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ABSTRACT

THE PREDICTION OF COLLEGE STUDENT

ACADEMIC PERFORMANCE AND PERSISTENCE:

THE SCHOOL TO COLLEGE TRANSITION

Hal A. Taylor, Jr.

May 10, 2003

This dissertation addresses the prediction of college student academic performance

and persistence of Jefferson County Public School graduates at the University of

Louisville. Using multiple regression and discriminant analysis, the research design

assesses the predictive potential of six Commonwealth Accountability Testing System

(CATS) scores and five college preparation variables beyond the predictive contribution

of control variables established by the literature. The control variables are high school

GPA, ACT score, race, sex, and socioeconomic status. The criterion variables are first

semester college GPA, first year college GPA, and persistence to the sophomore year.

High school GPA and socioeconomic status were statistically significant contributors to

each prediction equation. CATS scores accounted for a significant proportion of variance

in first year college GPA with control variables already in the equation.

This dissertation is divided into five chapters. Chapter I provides an overview of

Kentucky's recent education reforms, the purpose of the study, and the three research

questions. Chapter II is a review of the literature. The literature includes research on the

prediction of college GPA and persistence, prediction relative to nontraditional students, race, and gender, and information supply chain management. Information supply chain management is a business concept informative to this dissertation for its modeling of information flow between educational institutions. Chapter III describes the methodology. Statistical analysis includes descriptive statistics, hierarchical multiple regression analyses, and discriminant analysis.

Chapter IV is a summary of the results. The regression models accounted for 20.1% ($p < .01$) of the variance in first semester college GPA and 31.4% ($p < .01$) of the variance in first year college GPA. The discriminant function accurately identified 69.0% ($p < .01$) of students not returning to the university for their sophomore years. Chapter V, a discussion of the results, includes considerations for educators, researchers, and the application of information supply chain principles to the collaboration between Kentucky's public education systems.

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ACADEMIC PERFORMANCE AND PERSISTENCE:
THE SCHOOL TO COLLEGE TRANSITION

By

Hal A. Taylor, Jr.
B.S., United States Air Force Academy, 1989
M.S., Lesley University, 1993
M.A., University of Louisville, 2002

A Dissertation
Submitted to the Faculty of the
Graduate School of the University of Louisville
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for the Degree of

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College of Education and Human Development
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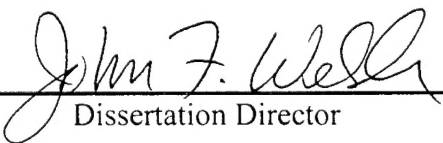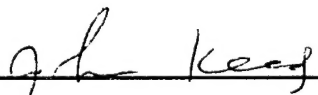THE SCHOOL TO COLLEGE TRANSITION

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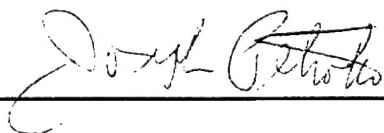M.A., University of Louisville, 2002

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CHAPTER I

INTRODUCTION

This dissertation addresses the prediction of college student academic performance and persistence for Jefferson County Public School graduates at the University of Louisville. This introduction includes the background of the study, an overview of the variables related to academic performance, the purpose of the study, the research problem and questions, and the significance of the study. The chapter concludes with a definition of terms and limitations of the study.

Background

Public education in Kentucky was the target of extensive legislative reform efforts during the past twelve years. Two bills passed by the Kentucky Legislature, one focused on secondary education and one on postsecondary education, directed reform efforts to improve public education. The problem of this research arises from the nexus of these two bills, the transition for Kentucky public high school graduates to a Kentucky public university. The purposes of the Kentucky Education Reform Act of 1990 (KERA) and the Kentucky Postsecondary Education Improvement Act of 1997 complete the background for this study.

Kentucky Education Reform Act of 1990

The Kentucky Supreme Court ruled the state's secondary public education system inadequate and unconstitutional in 1989. This ruling required the General Assembly to

recreate the state's secondary education system (Kentucky Board of Education, 2000). The Kentucky Education Reform Act of 1990 (House Bill 940, May 1990 Regular Session) was the product of their efforts. The court listed seven capacities Kentucky secondary schools must teach their students. The capacity specifically relevant to this study is a requirement that high school graduates be well-prepared to choose and pursue their life's work intelligently. This capacity encompasses college preparation.

In its 2001 Strategic Plan, the Kentucky Board of Education reflected the Kentucky Education Reform Act's (KERA) emphasis on improved secondary student learning in its six goals for student performance: (a) every student in school and making strong progress, (b) every student achieving at high levels, (c) every student reading at or above proficient level, (d) every Kentucky Department of Education employee working to enhance student success, (e) every school accountable for student learning, and (f) every graduate ready for postsecondary education and/or work. This final goal, preparation for postsecondary education and/or work, consisted of the following four points: (a) increase in rigor of secondary programs, (b) increase in students meeting skill standards, (c) increase in students meeting full graduation requirements, and (d) increase in students enrolling in and continuing in postsecondary education after successfully completing one year of initial enrollment. The Kentucky Legislature's intentions, enacted by KERA in 1990, are integrated into Kentucky's Department of Education and Board of Education goals and policies, and subsequently implemented by specific school districts.

Jefferson County Public Schools

Jefferson County Public Schools (JCPS), Kentucky's largest school district with over 95,000 students enrolled, mirrors the intent of KERA in its goals and objectives. In its

2001 Annual Progress Report, JCPS listed the following goal for student achievement: all JCPS students will become critical thinkers and lifelong learners who are academically prepared in a racially integrated environment to be successful in the postsecondary education programs or careers of their choice. Additionally, the JCPS Board of Education described five desired results for this goal. One desired result is for area employers and postsecondary school representatives to verify that JCPS graduates are academically and technically well prepared (Jefferson County Public Schools Board of Education, 2001).

Following the requirements of KERA and the leadership of the Kentucky Board of Education, the Jefferson County Public School system is focused on producing graduates prepared for life's challenges after graduation. In summary, Kentucky's Legislature, State Department of Education, State Board of Education, and the Jefferson County Public School system committed their resources and efforts to prepare interested students for success in postsecondary education. In addition to the reform efforts directed at secondary education, the Kentucky Legislature challenged the state's system of postsecondary public education to improve with the passage in 1997 of the Kentucky Postsecondary Education Improvement ACT (House Bill 1, May 1997 Special Session).

Kentucky Postsecondary Education Improvement Act of 1997

The 1997 Kentucky Postsecondary Education Improvement Act changed significant aspects of postsecondary education in Kentucky. This act created the Kentucky Council on Postsecondary Education (CPE) to implement and oversee these changes. CPE uses the following five questions (Kentucky Council on Postsecondary Education, 2001) to gauge the success of reform efforts targeted at improving Kentucky's postsecondary

education: (a) Are more Kentuckians ready for postsecondary education?; (b) Are more students enrolling?; (c) Are more students advancing through the system?; (d) Are we preparing Kentuckians for life and work?; and (e) Are Kentucky's communities and economy benefiting? Of these five measures of success, the first three imply a connection between Kentucky's secondary and postsecondary education systems in regards to preparation for college work at the high school level, transition between the two systems, and student progress through the postsecondary system toward graduation.

The Council on Postsecondary Education uses specific indicators to measure success toward each objective (Kentucky Council on Postsecondary Education, 2002). The first measure of success is Kentuckians' preparation for postsecondary education. Five indicators attached to this measure are: (a) ACT scores of high school graduates, (b) number of high school graduates taking the ACT, (c) number of college-level courses taken per 1,000 high school juniors and seniors, (d) number of high school graduates completing the ACT core coursework, and (e) high school test score averages. The indicators for the second success measure, enrollment in postsecondary education, include statistics describing the number of recent high school graduates and adults attending Kentucky postsecondary institutions, both overall and from target counties. The third measure, student advancement through the postsecondary system, includes indicators of persistence, completion, and graduation, such as the one-year retention rate of first-time freshmen and the six-year graduation rate of bachelor's degree students. The CPE also established enrollment, retention, and graduation goals for each of the state's eight public universities. The University of Louisville, the second largest university in the state with an enrollment of approximately 20,700, responded to these external

pressures for improvement from the Kentucky Legislature and the Council for Postsecondary Education with programs and initiatives tailored to its unique status as a metropolitan university.

University of Louisville

In response to the 1997 Kentucky Postsecondary Education Improvement Act (KPEIA), the University of Louisville (U of L) initiated the *Challenge for Excellence*, a ten-year plan to meet the state's expectations and achieve national recognition as a premier metropolitan university (Shumaker, 2001). The *Challenge for Excellence* addresses numerous aspects of university operations. One *Challenge for Excellence* objective pertinent to this study is improvement in the retention rate for full-time freshmen.

The University of Louisville faces significant challenges in achieving these goals by the year 2008, particularly in regards to its graduation rate, which according to CPE's Key Indicators was the lowest of the eight state public universities in 2001 (Kentucky Council on Postsecondary Education, 2002a). The 2001 freshman retention rate was 70.8%. The goal is 78% by the year 2008 (University of Louisville, 2001). The goal for the six-year graduation rate for first-time, full-time freshmen is 45% by 2008. The 2001 graduation rate was 32.3%.

U of L's *Challenge for Excellence* initiatives address each of the state's five questions guiding postsecondary reform. Of these initiatives, the first item on U of L's Action Agenda 2001-06, a document summarizing U of L's plan to achieve its goals and the state's objectives, plainly states the importance of the connection between U of L and the Jefferson County Public School system. In answering the question concerning the

preparation of Kentuckians for postsecondary education, the University of Louisville plans to "continue to work closely with Jefferson County Public Schools ... to better align curriculum and standards in order to prepare students for all levels of education" (Kentucky Council on Postsecondary Education, 2002a). Of the eight state public universities, only U of L highlights the importance of a relationship with one secondary school district as critical to its own success. Fifty-seven percent of U of L students are Jefferson County residents (University of Louisville, 15 July 2002).

Study Context

The context of this study has two components. First, the background information on Kentucky's educational environment is pertinent. The University of Louisville is striving to achieve its own goals under the Challenge for Excellence and the state's requirements in accordance with the 1997 Postsecondary Education Improvement Act. The Jefferson County Public School system is striving to meet its goals in accordance with the 1990 Kentucky Education Reform Act. Missions, goals, and students overlap institutions. This study will investigate the unique relationship between U of L and JCPS for significant predictors of college student academic performance and persistence.

The second component of this study's context is from a national perspective. A convergence of two issues created a controversy surrounding the use of SAT and ACT scores for college admission. The first issue related to an overall drop in predictive validity of conventional aptitude measures on college GPA. The second issue focused on the potential bias and differential validity of the SAT and ACT tests in regards to race, sex, and geographic location (Dalton, 1976; Wainer, Saka, & Donoghue, 1993). Some researchers question the utility (Larson & Scontrino, 1976), validity (Dalton, 1976;

Wainer, Saka, & Donoghue, 1993), and cost-effectiveness (Crouse & Trusheim, 1991) of

colleges' SAT and ACT requirements, traditionally accepted measures for university

admission decision-making. Crouse and Trusheim argued that the benefits a college

derives from including aptitude test scores in its admission process were minimal. The

reason postsecondary institutions continue the requirement, Crouse and Trusheim stated,

is because an alternative evaluation tool has not been provided.

In spite of these assertions over the past half-century by critics of aptitude testing, over

1,600 colleges and universities required SAT scores for admission as of 1991. If the

predictive validity, utility, and fairness of these two tests were suspect, are there not

better predictors available for admissions decision-making? This study will investigate

the predictive ability of variables unique to Kentucky, Commonwealth Accountability

Testing System scores, in relation to ACT scores and other conventional predictors.

Problem

Kentucky is heavily invested, literally and figuratively, in the academic progress and

success of its residents. Kentucky's economic future is connected closely to the success

of its educational institutions. The current pressures for improvement in secondary and

postsecondary education in Kentucky create an environment where positive results are

expected in the education of students, in their progress through the educational system,

and in their advancement toward educational goals. Educators cannot, however, facilitate

positive student outcomes without first understanding the factors related to college

student academic performance and persistence. The problem of this study, therefore, is

the lack of understanding in regards to the predictive relationship between conventional

predictors of college student performance (ACT score, high school GPA, sex, race, and

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socioeconomic status) and those predictors specific to Kentucky (CATS scores) and the Jefferson County Public School system (college preparatory courses).

Purpose

The purpose of this study is to explore the predictive potential of variables unique to Kentucky and specific to the Jefferson County Public School system in the prediction of college student academic performance and persistence at the University of Louisville for JCPS graduates. The magnitude of the relationship between these two institutions, by volume of students graduating from JCPS to U of L, and the criticality of its success, under the requirements of KERA and KPEIA, merit investigation. With a better understanding of the relationship between predictors and criterion variables for this shared student population, administrators at both institutions can make decisions and implement policies to encourage and support student success at all educational levels.

This research addresses variables specific to Kentucky's secondary education system (Commonwealth Accountability Testing System scores) and Jefferson County Public Schools (college preparatory courses). CATS scores and college preparatory course completion are the independent variables of interest. The three criterion variables are measures of student performance in college and progress toward educational goals. First semester college GPA and first year college GPA are significant predictors of continued enrollment and graduation (Clarkson & Roscoe, 1993). Persistence to the sophomore year is a measure of progress toward the student's personal goals, the goal of the institution to retain its student body to graduation (Tinto, 1993), and the goal of the Commonwealth to achieve its educational objectives (Kentucky Council on Postsecondary Education, 2002). The passage of the Kentucky Education Reform Act in

1990 and the Kentucky Postsecondary Education Improvement Act in 1997 focus this study's purpose on better understanding the variables related to the critical student transition from one Kentucky school district to one Kentucky university

Research Questions

The review of the literature regarding college student academic performance and persistence, viewed in light of Kentucky's educational reforms since 1990, provided the foundation for three research questions. The three research questions, accompanied by their null hypotheses, are listed below.

1. Are student CATS scores and college preparatory course completion in high school significant predictors of first semester college GPA beyond the contribution of the control variables?

   Null hypothesis 1 (H1): Student CATS scores and college preparatory course completion in high school make no significant contribution to the prediction of first semester college GPA beyond that of the control variables.

2. Are student CATS scores and college preparatory course completion in high school significant predictors of first year college GPA beyond the contribution of the control variables?

   Null hypothesis 2 (H2): Student CATS scores and college preparatory course completion in high school make no significant contribution to the prediction of first year college GPA beyond that of the control variables.

3. Are student CATS scores and college preparatory course completion in high school significant discriminators of persistence after one year of college beyond the contribution of the control variables?

Null hypothesis 3 (H3): Student CATS scores and college preparatory course completion in high school make no significant contribution to the discrimination of persistence after one year of college beyond that of the control variables.

Definition of Terms

The following definitions apply to this study:

1. Academic performance – a student's earned grade point average, both from high school and college, as recorded by the institution in the student's record.

2. CATS scores – Commonwealth Accountability Testing System scores; secondary school students in Kentucky test in various areas during different times in their academic careers; the scores of interest for this study are the following: (a) the reading scores from the 10th grade; (b) science, mathematics, and social studies scores from the 11th grade, and (c) two writing score from the 12th grade. Two additional CATS scores, practical living/vocational studies (10th grade) and arts/humanities (11th grade) were unavailable.

3. College preparatory course completion – defined two ways: (a) completion of the college preparatory curriculum endorsed by the American College Testing (ACT) Board of four English courses, three math courses at or above the level of algebra and geometry, three natural science courses, and three social science courses, and (b) completion of three math courses taught by the Jefferson County Public Schools (pre-calculus, calculus, and college preparatory algebra).

4. Persistence – a student's continuing enrollment at the university with a goal of program or degree completion.

Significance of the Study

The significance of this study rests upon a view of the results from the following three perspectives: national, state, and local. First, the national perspective encompasses this study's contribution to the overall body of research in regards to the prediction of college student academic performance and persistence. Since the early correlational studies of Klugh and Bierly (1959), Hills (1964), and Munday (1965), researchers pursued improved prediction methods through the use of theoretical models (Tinto, 1975), previously untested variables (e.g., personality, demographic, attitudinal), and increasingly sophisticated statistical procedures. This study builds upon that body of research by assessing the predictive potential of Kentucky's CATS scores and Jefferson County Public School's college preparatory courses on college academic performance and persistence.

A second perspective from which this research effort gains significance is from a state level. Kentucky's educational reform efforts significantly impacted secondary and postsecondary education in the Commonwealth. This study focuses on the intersection of Kentucky's two public education systems. These findings will provide some evidence for gauging the impact KERA (1990) and the Kentucky Postsecondary Education Improvement Act (1997) had on Kentucky high school graduate success at a Kentucky university.

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The final perspective focuses on the relationship between the University of Louisville and the Jefferson County Public School system. The magnitude of the relationship between JCPS and U of L, where over half of all U of L students come from Jefferson County (University of Louisville, 15 July 2002), suggests an interdependence worthy of study. This unique relationship between a large secondary school district and a metropolitan university provides opportunities to enhance student success if the dynamics of the relationship are understood. This study contributes to that understanding.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter reviews prior research about the prediction of college student academic performance and persistence. The first section of this chapter provides an overview of the controversy surrounding the use of conventional academic and aptitude variables for college admission decisions (Lavin, 1965). The second section focuses on the foundation of this body of research, the use of intellective and nonintellective predictors (Lavin, 1965) of college grade point average (GPA). Conventional predictors include aptitude and ability test scores, such as the Scholastic Aptitude Test (SAT) score and American College Testing (ACT) program score, and high school measures of grade point average (GPA) and rank in class. Nonintellective predictors include demographic variables, personality and attitude measures, perceptions, intentions, and other noncognitive factors.

The third section addresses the prediction of college student persistence. The fourth section addresses the prediction of student graduation. Nontraditional students, defined as postsecondary education consumers outside of the full-time, 18 to 22-year-old student age range or students at other than four-year universities (Baker & Velez, 1996) are the focus of the fifth section. The sixth and seventh sections provide an overview of academic prediction in regards to race and gender. The eighth section introduces a business concept, information supply chain management, pertinent to the relationship between the University of Louisville and the Jefferson County Public School system.

The final section is a summary with proposed advancements in the field of college

student academic performance and persistence prediction.

Background of the Controversy

The predictive utility and validity of traditional prediction variables (e.g., SAT, ACT,

and high school performance) is under scrutiny (Crouse & Trusheim, 1991). Racial

biases, decreasing correlations with actual college performance, and societal attitudes

concerning access to postsecondary education are examples of issues demanding the

attention of college officials and researchers. Finneran (1999), in *The Merits of*

Meritocracy, addressed some of the contradictory attitudes concerning academic

achievement. The dilemma faced by university admission officers was a requirement to

make enrollment decisions, discriminating between candidates based on admission

criteria, using measures critics charged as biased and unfair (Dalton, 1976).

Although the standardized testing gap between Whites and minorities has narrowed in

recent decades, it still exists (Eimers, 2001). Admission officers need some standard on

which to base admissions decisions. One purpose of using grades and tests in admissions

decisions is to differentiate among individuals (Finneran, 1999). The key for

postsecondary administrators is in wisely selecting their admission criteria, understanding

its limitations, and fairly applying the standard across all applicants.

Stern and Briggs (2001) discussed the pressures, forces, and developments influencing

postsecondary admissions policies. In addition to traditional pressures, such as

affirmative action, Stern and Briggs cited four trends prompting postsecondary

institutions to reconsider their admissions procedures. First, economic conditions favor

college graduates. The economic benefit to graduates is increasing. Male college

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graduates earned 54% more than high school graduates in 1996 compared to 24% more in

1970. Female college graduates earned 88% more than high school graduates in 1996

compared to 68% in 1970. Stern and Briggs hypothesized that a fast pace of economic

activity forces business and industry to demand more college graduates who are better

prepared to handle and exploit rapidly changing technologies. Second, college attrition

rates continue to be high. Traditional measures of college readiness, such as test scores

and grade point averages, leave much variance unexplained in attrition rates.

A third factor prompting college administrators to reconsider their admissions

procedures is unstandardized high school exit requirements (Stern & Briggs, 2001). Less

reliance on disciplinary courses and grades and more experimentation with experiential

learning, assessment tools, and statewide testing standards provide unique challenges to

college admission personnel. Fourth, the changing face of secondary education demands

flexibility and adaptability in the postsecondary admissions process. Charter schools and

home schools are not bounded by the traditional requirements of public education

institutions. Transcripts, course requirements, and pedagogy differ. These alternative

secondary education sources, home schools and charter schools, are increasing.

Some states responded to this changing environment in higher education admissions.

Wisconsin, Washington, and Oregon implemented programs to explore alternative

systems for assessing applicant potential for postsecondary admission (Stern & Briggs,

2001). Stern and Briggs raised two issues central to any discussion of this topic: money

and values. Any new system requires financial backing. Who pays for pilot studies, new

software, and personnel? Also, is a new system worth the price if the same values,

aptitude and potential, are being considered? Secondary education is reforming itself.

Postsecondary institutions, still placing significant emphasis on the traditional aptitude measures of the SAT and ACT test scores in their admissions process, have not aligned their admissions procedures to this changing secondary landscape. A debate continues regarding the fairness and utility of SAT and ACT scores.

SAT and ACT Test Scores

Researchers debate the appropriateness of college admission requirements for ACT and SAT scores. Crouse and Trusheim (1991) accepted two conclusions supported by numerous SAT validity studies: (a) addition of the SAT to the high school record improves colleges' best estimates of students' academic performance, and (b) prediction equations containing SAT scores and high school record data yield high correlations between predicted grades and actual grades. Those two conclusions alone do not constitute a basis upon which institutions should base their admissions decisions. Crouse and Trusheim argued the focal decision point for including SAT scores in admissions decisions should be the SAT's utility. Does the SAT improve significantly the admissions decision when viewed in light of the cost to the university, the cost to the applicant, and the relatively minor, frequently inconsequential, contribution it makes to the admissions process? A similar controversy surrounds the use of ACT scores.

Gordon (1974) explored the correlation between ACT and SAT scores. The study compared ACT-English to SAT-Verbal and ACT-Mathematics to SAT-Mathematics. This effort, computing correlations between the two most commonly used aptitude measures, contained potential utility for admissions personnel at universities accepting both tests. The study participants were freshmen ($N = 600$) entering Loyola University in

the fall of 1974. The sample included 549 students with ACT scores, 339 students with SAT scores, and 284 with both ACT and SAT scores.

Gordon (1974) calculated the correlation of SAT-Verbal to ACT-English and SAT-Mathematics to ACT-Mathematics. The correlation coefficient between SAT-Verbal and ACT-English was .648. The correlation coefficient between SAT-Mathematics and ACT-Mathematics was .798. Using these r values and the means for each score, Gordon computed four linear regression equations, one per variable, allowing estimation of one test score from the other. The high correlations between ACT and SAT scores, and the resultant linear regression equations, provided support for their continued comparative use in college admissions.

Lenning and Maxey (1973) compared the predictive efficiency of the SAT and the ACT on college freshman grades. The researchers gathered data from the ACT Standard Research Service files for the previous three years and identified 17 postsecondary institutions appropriate for the study's purpose. The institutions varied in main admission test used (ACT, SAT, or either), location (East, South, Midwest, Mountain-Plains, West, Southwest), type (public, private), highest degree offered (BS, MS, PhD), freshman enrollment (100 – 3800), and proportion of freshman class in summary group (.16 – 1.00). Of the 17 college data sets, three were from the 1968-1969 school year, three were from the 1969-1970 school year, and eleven were from the 1970-1971 school year.

Lenning and Maxey (1973) assembled the ACT Standard Research Service Summary Analysis data from each college and separated the sample into three categories. A TH-Index R statistic was the zero-order correlation between actual grades and an average of

grades predicted from ACT or SAT subtests and grades predicted from self-reported high school grades in ACT or SAT test subject areas. Eight colleges reported SAT and ACT correlations to college GPA for all students. For seven of these schools, ACT's correlation to GPA was higher than SAT's correlation to GPA. The ACT TH-Index R's ranged from .556 to .309.

The second group contained five colleges reporting student data with mixed SAT and ACT availability. For four of these schools, ACT's correlation with GPA was slightly higher than the SAT's correlation with GPA. The ACT TH-Index R's were nearly identical to the SAT TH-Index R's.

The final four schools reported TH-Index R's substantially different for SAT and ACT. For three of these schools, ACT's correlation with GPA was slightly higher than the SAT's correlation with GPA. The SAT TH-Index R's for three schools were slightly higher than the ACT TH-Index R's. Correlational comparisons within the 17 schools in the sample indicated the ACT predicted college GPA as well as, and consistently better than, the SAT. In addition to this research on the comparative validity of conventional aptitude test scores, a decline in validity was the focus of several studies.

Dalton (1976), replicating a longitudinal study at the University of Southern California (USC), tested the predictive validity of the SAT and high school achievement over time on college freshman grades. The USC study reported a decline in predictive validity. Dalton's sample population ($N = 17,533$) came from the following five entering freshman classes at Indiana University: (a) 1961, $n = 1,480$; (b) 1965, $n = 2,542$; (c) 1970, $n = 4,117$; (d) 1973, $n = 4,531$, and (e) 1974, $n = 4,863$.

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The continuous independent variables used by Dalton (1976) were SAT-Total score and high school percentile rank (HSR). The dependent variable was first semester college GPA. Dalton performed multiple regression, by gender, for each year group. For men, the multiple correlation coefficient ranged from .62 to .47. For women during the same period, the multiple correlation coefficient range was .64 to .49. The predictive validity of the SAT and HSR on freshman grades declined over time for both males and females. Dalton's (1976) results mirrored those reported in the USC study, providing evidence for a trend in lower predictive validities for SAT scores and high school achievement data.

Investigating a decreasing correlation of SAT scores to first year college grades, Wainer, Saka, and Donoghue (1993) focused their research on the University of Hawaii-Manoa (UH). Since 1982, the correlation of Hawaiian students' SAT scores to first year college grades dropped nearly to zero. The study participants were freshmen ($N = 2,791$) entering UH from Hawaiian secondary schools in either 1982 ($n = 1446$) or 1989 ($n = 1345$). A small percentage ($n = 50$) of the 1989 participants were from mainland schools for comparison purposes.

The independent variables, measured on the interval level, were SAT-Verbal (SAT-V) score, SAT-Mathematics (SAT-M) score, SAT-Total score, and high school grade point average (HSGPA). The dependent variable was first year college grades (FYG). The researchers analyzed the data using zero-order correlations, comparing 1989 data with 1982 data and national SAT statistics. Data from 1989 students from Hawaiian secondary schools yielded correlations between FYG and SAT-V (.19), SAT-M (.10),

and HSGPA (.32) lower than those for their 1982 cohorts (.26, .35, and .35, respectively) and the 1989 national averages (.44, .43, and .54, respectively).

Wainer, Saka, and Donoghue (1993) performed differential item functioning on the 1989 SAT data. The Mantel-Haenszel statistic, followed by an examination of the test items on the extremes of the statistic's scale, revealed no differential performance among Hawaiians to account for the low SAT-FYG correlations. The researchers attempted bivariate gaussian decomposition of the SAT-Total – FYG data to explore for data grouping within the distribution. Such separate grouping could have higher correlations but lose association when grouped with surrounding data. Two groups emerged from the decomposition procedure with correlations between SAT-Total and FYG of .21 and .23, still lower than their 1982 cohorts and the national average. Wainer, Saka, and Donoghue considered other possible explanations for a loss of SAT validity for Hawaiian-educated freshmen, such as Hawaii's unique status among the 50 states or unusual freshman course selection, but reached no satisfactory explanation.

Summary

A convergence of two issues created a controversy surrounding the continued use of SAT and ACT scores for college admission. The first issue related to an overall drop in predictive validity of conventional aptitude and ability test measures (SAT and ACT) on college GPA. The second issue focused on the potential bias and differential validity of the SAT and ACT tests in regards to race, sex, and geographic location (Dalton, 1976). If the predictive validity, utility, and fairness of these two tests were suspect, are there not better predictors available for admissions decision-making?

The prediction of academic performance in college is a dynamic endeavor. As students, society, and institutions change, the equations and processes admission offices use must change (Stern & Briggs, 2001). Postsecondary institutions experience pressure to respond to changing conditions in their recruitment, selection, and development of students. First semester college GPA is the first indicator of a student's progress toward degree completion. Grade prediction, whether focused on the first quarter, semester, year, or cumulatively, is of interest and concern to administrators and faculty.

The Prediction of College GPA

The prediction of college grade point average grew in importance when postsecondary education grew during the 1950s and 1960s and institutions received far more applications for admission than available openings (Lavin, 1965). University administrators needed tools to aid in the selection of their student bodies from the applicant pool. Prediction equations helped satisfy that requirement.

Research on the prediction of college GPA significantly expanded in the post-World War II era with an emphasis on conventional predictor variables such as high school GPA (Hills, 1964), high school graduation class rank (McDonald & McPherson, 1975), and aptitude test scores (Noble & Sawyer, 1989; Nisbet, Ruble, & Schurr, 1982). Researchers considered nonintellective variables, such as personality measures (Himelstein, 1965), attitudinal data (Wesley, 1994), and demographic factors (Misanchuk, 1977), to account for additional variance in college grade point average (GPA). The criterion for research studies was either short-term GPA (Klugh& Bierly, 1959) or long-term cumulative GPA (Wolfe & Johnson, 1995). This section's review of GPA predictors includes subsections addressing the prediction of specific course grades,

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first semester GPA, first year GPA, cumulative GPA, and the use of the high school record as a source of additional predictive power.

The Prediction of Specific Course Grades

Noble and Sawyer (1989) examined the validity of ACT scores and self-reported high school grades to predict performance in 12 types of English and mathematics freshman college courses. The researchers analyzed data from 233 of the 277 institutions that participated in the American College Testing Program's predictive research service between 1980 and 1984. Data collection included student data from the ACT predictive research service and course descriptions from institution questionnaires and catalogs.

The predictor variables included the four ACT test scores and self-reported high school grades in the four ACT test subject areas (English, mathematics, social studies, and natural sciences). The criterion variables were specific course grades in one of the following 12 types of freshman English and mathematics courses: (a) grammar; (b) writing; (c) grammar and writing; (d) grammar, literature, and writing; (e) grammar, reading, and writing; (f) algebra; (g) calculus; (h) computer science; (i) accounting; (j) algebra and arithmetic skills; (k) algebra and trigonometry; and (l) analytic geometry and calculus. Noble and Sawyer used three combinations of predictors (ACT test scores, high school grades, and ACT test scores combined with high school grades) in their multiple regression analyses.

Noble and Sawyer's results indicated the combined model was a significantly ($p <$ .01) better predictor of college grades than ACT scores alone. ACT scores were better predictors than self-reported high school grades. Multiple R values in specific course types across institutions were compared using a median R value. Of the mathematics

courses, accounting had the highest median R of .56. The remaining six mathematics course types' median R's were within .10. Median R's for the English courses ranged from .48 to .55. Additional analysis included dividing the sample between selective and non-selective institutions and between 2-year and 4-year institutions. Median R's in the English groups were slightly higher at non-selective institutions. Two-year colleges' median R's were higher for grammar than 4-year institutions. ACT scores and high school grades, in addition to their traditional use as college GPA predictors, held predictive validity for specific college course grades.

Responding to the relative unpredictability and unexplained variance associated with college grade point average (GPA), Goldman and Slaughter (1976) selected a criterion similar to that selected by Noble and Sawyer (1989): individual course grades. The theoretical basis for this investigation was GPA's composite nature of averaged grades from a variety of courses in separate disciplines with unique grading systems and heterogeneous student pools. Single course grades contained fewer opportunities for introduced ambiguity and variance. The participants were students ($N = 254$) in five undergraduate classes at the University of California, Riverside, in the fall of 1974. The courses, each at the introductory level, were in psychology ($n = 100$), biology ($n = 33$), chemistry ($n = 33$), physics ($n = 68$), and sociology ($n = 20$).

The continuous predictor variables were SAT-Verbal (SAT-V), SAT-Mathematics (SAT-M) score, and high school GPA (HSGPA). The criterion measures were specific grades in one course. The researchers computed correlations and multiple regression equations for each class.

Goldman and Slaughter (1976) reported a significant ($p < .01$) average multiple correlation between course grade and SAT scores plus HSGPA of .49. Using Ghiselli's formula for predicting a composite's correlation to an outside variable, the researchers predicted a GPA composed of 30 grades, each correlated to the independent variables at .49, would hold a multiple correlation of .70 to SAT scores and HSGPA. The literature and Goldman and Slaughter's previous research did not produce this high correlation. Unexplained variance resided in the criterion measure, not solely in the predictors. These results supported the researchers' hypothesis that the validity concerns regarding traditional college success predictors, such as the SAT, should focus on removing variability from the criterion measure, college GPA. Individual course grades, contrary to traditional measures that increase with additional assessments, correlated at levels of significance comparable to their composite measure of GPA.

Norton-Welsh and Reding (1992) went beyond this consideration of a single course grade to examine the predictability of GPA in a grouping of similar courses. Norton-Welsh and Reding studied the relationship between selected variables and successful performance in an accounting program. Study participants were juniors ($N = 367$) entering the accounting program at a large midwestern university in the autumn terms of 1987 and 1988. The researchers defined success more broadly than in past studies by including grades from all seven required accounting courses taken during the junior and senior years.

Five predictor variables included three interval-level predictors and two nominal-level predictors: (a) American College Test (ACT) score, (b) grade point average (GPA) in freshman and sophomore business tool courses, (c) score on the Admission Qualifying

Examination (AQE), (d) sex, and (e) accession status (native or transfer). Two dependent variables, both interval data, were examined separately. The first criterion measure (AVG-1) was GPA in three intermediate accounting courses most frequently completed in the junior year. The second criterion measure (AVG-2) was GPA in all seven accounting courses most students complete within two years from acceptance into the program.

Both criterion measure (AVG-1 and AVG-2) were paired with each cohort group (1987 and 1988) in four stepwise multiple linear regression analyses. Only students with passing grades in all seven courses entered the equation. AQE, GPA, and ACT best predicted AVG-1 ($R = .412$) and AVG-2 ($R = .454$) for the 1987 group ($n = 192$). GPA and AQE best predicted AVG-1 ($R = .353$) and AVG-2 ($R = .422$) for the 1988 group ($n = 175$). Prediction improved significantly for seven courses from three. GPA for both year groups accounted for greater variance when predicting GPA for seven courses. Sex and accession status did not contribute to the equation. ACT added little to the 1987 year group's regression models for AVG-1 and AVG-2 (partial R of .014 and .008, respectively).

Misanchuk (1977) challenged the traditional multiple regression approach to predicting academic achievement by incorporating Atkinson's model of the dynamics of cumulative achievement using discriminate analysis techniques. The researcher developed instruments to collect data on cumulative achievement to differentiate and predict scholastic success in a university course. Participants were students ($N = 804$) enrolled in one of three courses (freshman geography, freshman chemistry, or introductory economics) at a large midwestern university.

Survey data analysis generated 17 standardized discriminant function coefficients. The survey contained 58 items divided into the following composite subscales: (a) fear of failure, (b) daydreaming related to achievement motivation, (c) locus of control, (d) academic values, (e) incentives to achieve in the course, (f) level of performance while at work, (g) amount of time spent at work, and (h) motivation for alternatives. The remaining coefficients were gender, SAT score, daydreaming related to achievement motivation (quadratic term), fear of failure (quadratic term), efficiency ratio (level of performance while at work/SAT), interaction of level of performance and the amount of time spent at work, strength of motivation for the task, and two dummy variables (nature of the task 1 and nature of the task 2). The survey contained 15 nine-point Likert-type scales, 31 five-point Likert-type scales, and 12 forced choice responses. Coefficients of generalizability for the eight subscales ranged from .56 to .86, averaging .70. The index of cumulative achievement used was the grade earned in the course, converted to numerical terms (A = 5, B = 4, C = 3, D = 2, and F = 1).

Misanchuk (1977) withheld a cross-validation group from the original calculation and computed a step-wise discriminant analysis. Two of the three discriminant functions were significant at the .001 level. The number of correct classifications, those exact or within two standard deviations, in the cross-validation group was 57.3%. If interpreted in the context of minimizing social cost, where underpredicting grades and supplying unnecessary remediation is preferable to overpredicting grades and overlooking remediation for a poor student, a prediction rate of 77.1% was reported. Misanchuk's application of Atkinson's cumulative achievement model indicated discriminate analysis significantly predicted achievement in one course.

Gordon (1989) assessed the predictive validity of intention and expectation measures on academic performance in one college course. Based upon prior research in the field of attitude-behavior consistency, Gordon expected better prediction and variance accountability from expectations than intentions. The subjects were undergraduates ($N = 166$) enrolled in general education courses within a psychology department at a southeastern university. Participants had previously taken the first course exam. The sample, 80 men and 86 women, was randomly assigned to either the expectation or intention group.

The predictor variables were participant responses to the following three questions, tailored to the expectation or intention group: (a) I intend (expect) to make a(n) (circle one of the following) A, B, C, D, F on the next test in this class; (b) I intend (expect) to make a(n) (circle one of the following) A, B, C, D, F on the final exam in this class; and (c) I intend (expect) to make a(n) (circle one of the following) A, B, C, D, F as a final grade in this class. The researcher computed correlations between participant responses and actual performance. Paired t-tests indicated expectations were significantly ($p < .05$) better predictors of performance than intentions. The mean correlation between expectations and performance in all three categories was .55, compared to .44 for intentions.

Multiple regression analyses, with the results of the first exam already in the model, indicated expectations were significant contributors to the equations predicting next test grade ($p < .05$), final exam grade ($p < .001$), and final course grade ($p < .001$). Intentions contributed significantly only to the equation for next test grade ($p < .01$). Gordon's (1989) finding supported the use of expectation measures as predictors of academic

performance. Intention aided prediction in the short-term; expectation held predictive power over the course of the semester.

Summary. These researchers attempted to predict one specific college course grade, or the grades from a small group of courses, using different statistical techniques and predictors. The predictors (high school performance, aptitude measures, attitudinal data, and prior college performance) contributed variably to the prediction equations and discriminant functions. The discriminant analysis demonstrated that intrinsic variables combined with aptitude and personality measures could accurately identify students in need of remediation (Misanchuk, 1977). Noble and Sawyer (1989) provided evidence that individual course grades correlated more highly with ACT scores than self-reported high school grades. Though attempted less frequently than the prediction of cumulative GPA, these investigations' results indicated the prediction of specific college course grades was theoretically possible and held potential. The following subsection addresses a more common criterion, first semester college GPA.

The Prediction of First Semester GPA

Klugh and Bierley (1959) had two goals for their study. First, they tested the validity of the School and College Ability Test (SCAT) as a predictor of first semester freshman liberal arts grade point average (GPA) at Alma College. Second, they assessed predictive improvement when adding high school GPA to the equation. The participants were first semester freshmen ($N = 430$) entering Alma College in 1956 and 1957. The researchers computed correlations and performed multiple regression analyses separately by gender and year group.

The interval-level predictor variables were the SCAT, Form 1C total score and high school GPA. Participants completed the SCAT after acceptance by the college. The criterion variable was first semester college GPA.

Klugh and Bierley's (1959) results indicated females earned higher high school and college GPAs. Males scored higher on the SCAT. The four regression models, containing SCAT and high school GPA as predictors, were significant at the .01 level. The multiple correlations for males in 1956 ($n = 106$) and 1957 ($n = 125$) were .670 and .661, respectively. The multiple correlations for females in 1956 ($n = 97$) and 1957 ($n = 102$) were .684 and .782, respectively.

McDonald and McPherson (1975) tested the predictive utility of demographic variables on first semester college GPA compared to the ACT-Composite score and high school rank. They predicted that work hours, scholarship support, and credit hours taken would significantly influence college GPA. Unmarried, White students ($N = 152$) in the Principles of Economics classes in 1973 at the University of Illinois at Chicago Circle completed a questionnaire to provide the sample data.

The researchers conducted three multiple regression analyses. The predictor variables were ACT-Composite score, high school percentile rank (HSR), sex, scholarship dollars per quarter, weekly work hours, credit hours taken, and the following five dummy-coded variables describing high school location and type: (a) city parochial, (b) suburban public, (c) suburban parochial, (d) not in Chicago area, and (e) non-city. The criterion was college grade point average for the previous academic quarter.

The first regression equation, computed using only ACT-Composite score and HSR, produced a multiple R of .29. The second equation, with the set of the first four high

school dummy codes added, produced a significantly higher multiple R of .36. The final regression equation, after adding the remaining socioeconomic variables and replacing the set of high school dummy codes with the fifth high school variable, yielded a multiple R of .52. Sex, HSR, and high school location (Chicago, non-Chicago) contributed to the equation at the .001 level of significance. ACT-Composite score and credit hours taken were also significant ($p < .05$) contributors. The findings reported by McDonald and McPherson (1975) support the inclusion of certain demographic and situational variables with academic aptitude measures to sharpen the prediction of college grade point average for unmarried, White students. Maryland's Higher Education Commission included similar demographic and personal variables in its examination of college student achievement.

In 1997, the Maryland State Higher Education Commission (MSHEC) examined Maryland high school graduates' performance in high school compared to their first year in college. This study, part of Maryland's annual Student Outcome and Achievement Report (SOAR) distributed to state educators, focused on students graduating high school during the 1994-1995 school year and enrolling in Maryland colleges during the 1995-1996 academic year. Their report examined the differences between college students who did or did not complete a college preparatory course in high school.

The MSHEC defined college preparatory courses, or 'core', as four or more years of English, three or more years of mathematics, three or more years of science or history, two or more years of natural sciences, and two or more years of a foreign language. Measures of college performance included need for remedial assistance in mathematics, English, and reading, plus grades in first English and mathematics courses, and

cumulative grade point average (GPA). In all areas of remediation, a greater percentage of non-core students required assistance than core students. Core student earned an average grade of 2.4 in their first mathematics course, compared to 2.2 for non-core students. Core students earned an average grade of 2.6 in their first English course, compared to 2.4 for non-core students. Core students' cumulative GPA after one semester, 2.5, exceeded non-core students' 2.2.

A stepwise multiple regression analysis identified the best predictors of college performance. The predictor variables were 66 items from the SAT and ACT questionnaires and SOAR demographic data. The criterion variables were first semester college GPA, first mathematics grade, and first English grade. Results of the multiple regression indicated high school GPA as the single best predictor of each criterion variable. Gender, SAT verbal and math scores, father's educational level, and average grade in high school subject courses also proved to be strong predictors. In addition to the demographic variables considered in the previous two studies, personality measures were a potential source of variance explored by researchers.

Himelstein (1965) investigated the predictive potential of noncognitive personality variable on college performance. His focus was on seven Minnesota Multiphasic Personality Inventory (MMPI) subscales, their intercorrelations, and their relationships with measures of scholastic aptitude and scholastic achievement. Participants were freshmen ($N = 281$) enrolled in Introductory Psychology at New Mexico State University.

The seven interval-level MMPI subscale predictor variables were academic achievement (Ac, 18 items), college achievement (Ae, 26 items), graduate school potential (Gr, 14 items), honor point ratio (Hr, 16 items), intellectual efficiency (Ie, 39

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items), originality (Or, 25 items), and underachievement (Un, 22 items). The criterion variables were American College Test (ACT) score and first semester GPA. All participants had a GPA. One hundred and eighty-one participants had an ACT score.

Himelstein (1965) computed Pearson correlations to analyze the data. With the exception of underachievement, all MMPI subscales significantly correlated with GPA at the .05 level. ACT held the highest correlation ($r = .596$) with GPA. All MMPI subscales correlated significantly with ACT. Each subscale's correlation with ACT was slightly higher than for GPA. MMPI noncognitive measures held validity as predictors of academic aptitude and academic achievement.

Nisbet, Rubie, and Schurr (1982) also assessed the efficacy of adding a battery of personality and skills inventory assessments to aptitude test scores, but included high school percentile rank (HSR) in predicting second quarter college GPA and third quarter completion. The researchers attempted to develop additional tools for university faculty and staff for advising high-risk college students. The participants ($N = 658$) were matriculating freshmen at Ball State University in 1978. Low SAT-Verbal scores (320-360) and high school rank (25th-50th percentile) resulted in each participant's placement into the Academic Opportunity Program for high-risk students.

The 37 predictor variables included SAT-Verbal score, SAT-Mathematics score, HSR, five Effective Study Test (EFST) scores, 15 Myers-Briggs Type Indicator (MBTI) scores (four main effects, six two-way interactions, four three-way interactions, and one four-way interaction), three Nelson Denny Reading Test (NDRT) scores, and eleven Holland Vocational Preference Inventory (HVPI) scores. The criterion variables were second quarter GPA and a dummy-coded variable indicating completion of the third quarter (yes,

no). Hierarchical multiple regression on GPA started with SAT scores and HSR, followed by the scores for the EFST, the MBTI, the NDRT, and the HVPI. Third quarter completion was regressed on the significant predictors from the first analysis plus second quarter GPA.

The findings reported by Nisbet, Rubie, and Schurr (1982) revealed SAT scores, HSR, the EFST scores, and an MBTI main effect contributed significantly ($p < .005$) to the prediction of second quarter GPA ($R^2 = .16$), a 67% improvement over SAT scores and HSR alone. These significant predictors and second quarter GPA accounted for 22% of the variance in third quarter completion. The study's results supported additional consideration of skill and personality variables to augment the power of high school performance and aptitude measures in predicting college grade point and persistence.

Multiple regression and discriminant analysis are not the only statistical tools available to the researcher interested in the prediction of academic performance. A structural model of the consequences of success attributions was the focus of Platt's 1988 study. Platt applied the attributional model of achievement motivation from past research to a long-term achievement environment, high school, to predict first term college performance. The premise of the study was that different attributions for success and failure have distinct impacts on affective reactions, expectancies, behavior, and ultimately, performance. The study took 208 participants from the entering freshman class in a selective program in the College of Engineering at a large midwestern university in 1985.

Platt's (1988) hypothesized model predicted success attributions of ability, task ease, luck, and effort would influence a second set of factors: expectancies, predicted effort,

and academic self-concept. The second set of factors would, in turn, predict first semester grade point average (GPA). Participants completed questionnaires during an engineering orientation. The instrument gathered data on participant perceptions of high school success, attributions, expectancy of success, predicted effort, and academic self-concept. Using the LISREL IV software package, Platt analyzed the independent variables' predictive relationship to first semester college GPA.

The final LISREL model closely approximated Platt's hypothesized model. The following associations were in the positive direction. Attribution to ability was significantly ($p < .05$) related to expectancy and academic self-concept. Attribution to effort was significantly related to predicted effort and academic self-concept. Attribution to task ease or luck did not contribute significantly to any second-tier factors. Academic self-concept was related to expectancy. Expectancy and predicted effort were significantly associated with each other and, in turn, significantly predicted GPA. Causal attributions for ability and effort, linked in a structural model, positively influenced the predictive power of expectancy and predicted effort on first semester college GPA.

Summary. The investigators studying the prediction of first semester college GPA explored the potential of numerous predictors in their effort to account for larger proportions of variance in the criterion. High school GPA and aptitude measures (e.g., SAT, ACT, and SCAT) consistently made significant contributions to the prediction equations (Klugh & Bierly, 1959; McDonald & McPherson, 1975). College preparation in high school significantly correlated to better college performance (Maryland, 1997). Personality variables, such as those created by the Minnesota Multiphasic Personality Inventory (MMPI) and the Myers-Briggs Type Indicator (MBTI), and attitudinal

measures provided significant contributions to the prediction equations beyond that of conventional academic variables (Himelstein, 1965; Nisbet, Ruble, & Schurr, 1982; Platt, 1988). The prediction of first year college GPA builds upon this foundation.

The Prediction of First Year GPA

Hills (1964) calculated multiple correlations between academic predictors and college freshman grade point average (FGPA) for students ($N = 27,961$) entering the University System of Georgia (USG) during the years 1958-1962 and completing the first year. The USG, with a total of 19 schools, included seven four-year colleges and universities, seven junior colleges, a woman's college, a military college, and three four-year colleges attended primarily by African-Americans. The USG initiated a requirement for SAT scores in 1958.

The academic predictor variables were SAT-Verbal (SAT-V) score, SAT-Mathematics (SAT-M) score, and high school average (HSA). Hills (1964) computed correlations and multiple correlations for each gender by institution and year. The average multiple correlation between FGPA and the predictors was .71 for women and .60 for men. The average multiple correlation for all students was .65. Using only HSA as a predictor for FGPA, Hills reported a multiple correlation for all students of .55. HSA was the best predictor, followed by SAT-V. Female FGPA was markedly more predictable than male academic performance.

More recently, Wade and Walker (1994) also assessed the predictive validity of high school and aptitude predictors, but included first and second year college GPA as criterion measures. Wade and Walker studied the effect of various traditional academic parameters on the academic performance of honors students at Southern University-

Baton Rouge. Their findings supported the use of multiple factors for assessing college academic potential. Participants were freshmen entering the honors program at Southern University-Baton Rouge. Sample size was not reported.

Wade and Walker (1994) utilized five predictors. High school graduation class size included four categories (≤ 99, 100-199, 200-299, and ≥ 300). High school graduation class ranking included four categories (1-10%, 11-20%, 21-30%, and $\geq 31\%$). High school grade point average included three categories (≤ 3.0, 3.1-3.5, and 3.6-4.0). The ACT-Composite score and ACT-Mathematical score, both interval data, included three categories (≤ 20, 21-24, and ≥ 25). The criterion variables were first and second year college cumulative GPA. High school Algebra I and II grade point averages were included in the statistical analysis of each predictor. Using the general linear model and least-squares means, the researchers used the Duncan Multiple Range Test to determine statistical significance ($p < .05$). The result was five tables, one for each predictor's relationship to the other predictors, Algebra grades, and criterion variables.

High school graduation class ranking and class size predicted no significant differences between the means for either criterion variable. Whereas the ACT Composite score only indicated a significant correlation with first year college GPA, correctly predicting higher GPAs for the highest ACTCS scores, the ACT Math score was significantly positively correlated with academic performance both years. High school GPA was significantly positively correlated with college academic performance.

Fincher (1974) also evaluated the predictive utility of the SAT, when combined with the high school record, to predict college grades. Fincher's study evaluated the SAT's effectiveness in terms of the frequency of its predictive contribution, the magnitude of its

contribution, and the incremental predictive improvement it provided when combined with the high school average (HSA). Fincher's data came from University System of Georgia (USG) norm booklets from 1958 – 1970. Norm booklets, published annually by the University System's Office of Testing and Guidance, contained score distributions, percentile ranks, correlations between predictor variables and academic grades, and regression equations for the prediction of grades in succeeding years for all postsecondary institutions in the USG.

During a nine-year period, 1958-1966, the USG published prediction equations annually for each institution's male and female freshmen populations. For 24 institutions over the nine years, the USG produced 168 equations for males and 163 equations for females. Eighty-eight percent of the male equations and 89% of the female equations contained significant predictive contributions from SAT-V, SAT-M, or both. HSA's correlation to college grades was always higher than the SAT's correlation to college grades. When combined, SAT consistently added predictive power to HSA. The predictability of freshmen grades for females was always greater than males.

Fincher (1974) computed a measure of predictive efficiency for SAT scores in the USG. SAT scores increased predictive efficiency 46% for males and 43% for females over HSA alone. Undefined variables and lack of data prevented a reliable calculation of the SAT's cost effectiveness. Fincher concluded the SAT's additive predictive power benefited the University System of Georgia's admissions decision-making, but listed future considerations critical to any discussion on SAT utility, such as social pressure for greater access to college attendance and the SAT's inherent value as a stand-alone measure of verbal and mathematics ability. Researchers explored other types of variables

(e.g., demographic, attitudinal, and personality) for additional sources of variance in first year college GPA beyond the high school record and aptitude test scores.

Research by Wright and Bean (1974) investigated the predictive utility of socioeconomic status (SES) and gender on college academic performance in a racially homogenous population. Wright and Bean hypothesized that the academic performance of lower socioeconomic groups was less predictable than higher socioeconomic groups. The sample participants were white, full-time freshmen ($N = 1,631$) in the 1970 freshman class at a large urban university. Participants completed the College Student Questionnaire.

The researchers divided the sample population four times, once each by sex (male, female), family income (less than $6,000, $6,001-$9,999, $10,000-$13,999, $14,000 and up), mother's education (less than high school diploma, high school diploma or more), and father's occupation (unskilled, skilled, business owner, and professional). Using SAT-Verbal score, SAT-Math score, and high school quintile rank as predictors and freshman year GPA as the criterion, Wright and Bean (1974) computed regression equations for the entire sample and for each level of the four categories for comparison.

The multiple R for the entire sample was .355. The multiple R for men (.372) was higher than for women (.327). Participants with high school diploma mothers produced a higher multiple R (.439) than those without (.318). The multiple R for a freshman whose father was a professional (.413) or small business owner (.486) was higher than for those from a skilled (.326) or unskilled (.330) household. Family income followed the same pattern. The multiple R for students with family incomes under $6,000 was .264 compared to .468 for students from families with incomes above $14,000. Wright and

Bean's (1974) results supported the hypothesis that high school performance, and to a lesser extent SAT scores, possessed lower predictive validities for lower SES groups. Where Wright and Bean highlighted predictive differences based on demographic variables, Hansmeier (1960) focused on the potential predictive contribution from a battery of intellective and psychological tests.

The twofold purpose of Hansmeier's (1960) study was to validate the Iowa Tests of Educational Development (ITED) against the criterion of college freshman GPA and derive a multiple regression equation to predict college freshman GPA at Iowa State Teachers College. The study participants were first time freshmen ($N = 401$) enrolled in the fall of 1954. Participants were single, non-veterans, and graduates of Iowa high schools.

The 18 interval-level predictor variables were: (a) nine individual test scores from the ITED; (b) ITED composite score; (c) summed scores of ITED tests 5, 6, and 7; (d) percentile rank in high school graduating class; (e) American Council on Education (A.C.E.) Psychological Examination, Q score and Total score; (f) Nelson-Denny Reading Test, Vocabulary score and Total score; and (g) Cooperative English Test, Mechanics of Expression score and Effectiveness of Expression score. The criterion variable was college freshman GPA.

Hansmeier (1960) computed zero-order correlations between each predictor and the criterion measure and intercorrelations between selected predictors. ITED composite score yielded the highest Pearson correlation ($r = .711$) with freshman GPA. ITED composite score combined with high school percentile rank yielded a multiple correlation of .768 against the criterion. A multiple regression analysis produced the following

prediction equation: freshman GPA = .090 + (.067)X_2 + (.011)X_3. X_2 was ITED composite score. X_3 was percentile rank in high school graduating class. The two measures combined accounted for 59% of the variance in freshman GPA.

Rugsaken, Robertson, and Jones (1998) compared the Learning and Study Strategies Inventory (LASSI) to traditional measures of academic aptitude on predicting freshman academic performance. The study focused on determining whether LASSI subscores enhanced the accuracy of traditional predictors, such as SAT scores, ACT scores, and high school rank. Participants, 4,805 entering freshmen at Ball State University (BSU) in 1994 and 1995, completed the 76-item LASSI during Freshman Orientation and completed two semesters at BSU.

The ten interval-level LASSI subscale predictors were attitude, motivation, time management, anxiety, concentration, information processing, selecting main idea, study aids, self-testing, and test strategies. SAT scores ($n = 4,311$), ACT scores ($n = 1,847$), or both scores and high school percentile rank (HSPR) were available for all participants. Rugsaken et al. (1998) used stepwise multiple regression analyses to determine the contribution of each predictor to accounting for variance in the dependent variables, first and second semester cumulative college GPA.

HSPR displayed the highest correlation with first ($r = .56$) and second ($r = .60$) semester cumulative GPA. When entered into the regression equation together, SAT and HSPR accounted for 36% and 40% of the variance in fall and spring GPAs, respectively. ACT and HSPR accounted for 39% and 45% of the variance in fall and spring semester GPAs, respectively. When added to the regression equation, the LASSI subscales accounted for an additional 2-3% of variance for each measure. Using stepwise multiple

regression with all predictors, HSPR was the strongest predictor, followed by aptitude test scores. Motivation and Time Management made modest, but significant ($p < .05$), contributions to each equation.

Summary. The prediction of first year college GPA builds upon the themes established regarding the prediction of first semester GPA. Researcher tested many variables for predictive utility. High school GPA and high school rank consistently led other variables in their contribution to the prediction equation (Hills, 1964; Fincher, 1974; Wade & Walker, 1994). Socioeconomic status (SES) contributed significantly when high, but its influence tapered off as SES dropped (Wright & Bean, 1974). Nonacademic variables, such as the LASSI subscales, consistently contributed power to the prediction. Hansmeier's (1960) high correlations between college GPA and ITED (Iowa Tests of Educational Development) scores held promise for further prediction refinements. The prediction of cumulative college GPA, whether cumulative over two years, four years, or until degree completion, is the next step in this line of investigation.

The Prediction of Cumulative GPA

Baron and Norman (1992) examined the predictive utility of the SAT along with achievement tests and high school rank on cumulative college GPA. They studied the role of restricted range, self-selection, and nonlinearity in their assessment. The participants in this study were entering freshmen at the University of Pennsylvania in 1983 and 1984. Due to underrepresentation, African-Americans and Hispanics were excluded, yielding a final sample of 3,816 students. The researchers used the admissions office predictive index (PI) system. The PI consists of three predictor variables, each weighted equally to 80 points apiece: (a) the mean SAT score, (b) the mean of three

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College Entrance Examination Board Achievement tests (ACH), and (c) high school class rank (CLR). The criterion variable was cumulative GPA at the university between the time of matriculation and 1988.

All three predictor variables were significantly correlated to cumulative GPA at the .05 level. CLR's correlation to cumulative GPA was .305, ACH's correlation was .261, and SAT's correlation was .199. Because SAT was highly correlated (.73) to ACH, and ACH was somewhat more highly correlated to CUM, multiple regression analysis indicated SAT was not useful in predicting CUM when ACH and CLR were known. SAT did not contribute to the prediction of cumulative GPA when achievement test scores and high school class rank were in the equation.

Baron and Norman (1992) also considered restriction of range, self-selection, and nonlinearity to explain SAT's lack of predictive power. Two University of Delaware researchers, Crouse and Keller, conducted a similar multiple regression analysis on 547 students at their university. The University of Delaware used lower admission standards and accepted applicants with a wider, less-restrictive range of entrance scores. Their results supported the nonsignificance of SAT when ACH and CLR were known. Self-selection, when student with high SAT scores select more difficult courses, could not alone account for SAT's nonsignificant regression weight. Analyzing the 83 courses with 175 or more study participants during the first two years of their college career, the researchers found significant negative correlations between grade earned and SAT (-.39), ACH (-.37), and CLR (-.36). Each predictor appeared closely related to self-selection into difficult courses. Finally, in testing for nonlinearity, the researchers added quadratic

terms to all predictors. SAT's contribution, when the other two predictors were known, continued to be nonsignificant.

Focusing entirely on personality variables as predictors, Schuerger and Kuna (1987) approached the prediction of cumulative GPA from a different angle. These two researchers examined the predictive utility of personality variables on college grades earned several years after subjects completed the personality inventory. The participants, 840 boys between the ages of 11 and 19 in a major urban area in the Midwest, completed Forms A and B of the High School Personality Questionnaire (HSPQ) and self-reported their most recent grades in four high school subject areas: English, social studies or history, mathematics, and science.

The predictor variables were the fourteen interval-level HSPQ scales: (a) warm, (b) intelligent, (c) calm, (d) excitable, (e) assertive, (f) enthusiastic, (g) conscientious, (h) bold, (i) sensitive, (j) individualistic, (k) worrisome, (l) self-sufficient, (m) self-controlled, and (n) tense. The criterion variables were the self-reported high school grades, parent-reported high school grades ten years later ($n = 144$), and cumulative college GPA from one university 76 participants attended. Schuerger and Kuna (1987) computed correlations and GPA prediction equations.

The best predictors were the HSPQ factors intelligent, conscientious, and self-controlled. Self-controlled and conscientious were significantly ($p < .05$) correlated with college GPA. The four prediction equations yielded values correlated to the criterion variables at levels ranging from .30 to .50. Schuerger and Kuna's results provided support for further consideration of personality variables as effective predictors of academic achievement.

Research by Wolfe and Johnson (1995) also examined the predictive validity of personality variables on college performance. The researchers' focus was on personality constructs measuring individual differences in self-control, conscientiousness, and self-discipline. The participants were psychology students ($N = 201$) at the State University of New York at Geneseo. The sample included 157 females and 44 males. Each subject completed the 320-item true/false Jackson Personality Inventory (JPI) and a 155-item questionnaire with 5-point Likert-type response format. The questionnaire yielded three subsets of personality variables: Big 3, Big 5, and Other.

The predictor variables were interval-level. The 16 JPI variables were anxiety, breadth of interest, complexity, conformity, energy level, innovation, interpersonal warmth, organization, responsibility, risk taking, self-esteem, social adroitness, social participation, tolerance, value orthodoxy, and infrequency. The Big 3 predictor variables were well-being, stress reaction, and control. The Big 5 predictors were extraversion, agreeableness, conscientiousness, neuroticism, and openness. The Other predictors were need for cognition, self-efficacy, self-handicapping, procrastination, alcohol use, marijuana use, religiosity, and attendance. Coefficient alphas, with the exception of alcohol use (.18), were above .60 for all variables. Academic predictors were high school grade point average (HSA) and SAT-Total score. The criterion was cumulative college GPA at the end of the semester. The researchers employed correlations and forward multiple regression to analyze the data.

Wolfe and Johnson's (1995) results revealed control, conscientiousness, and risk-taking were the personality variables with the highest Pearson correlations with college GPA at .38, .34, and -.31, respectively. Five regression analyses, one for each predictor

set and one for a combined set, indicated HSA consistently entered the model first. SAT-Total score was a significant contributor to each equation. *R*-square values ranged from .32 (Other and Big 5) to .35 (Big 3 and Combined) to .38 (JPI). The personality variables control and conscientiousness accounted for 9% of college GPA variance in three regression models, more than the SAT score contributed in any model. Wolfe and Johnson's findings supported further consideration of personality variables, particularly control and conscientiousness, as predictors of college performance.

Continuing with the focus on personality measures, Wesley (1994) developed a research design to investigate the additional predictive power of procrastination and self-handicapping behavior on academic performance in college when combined with SAT score and high school average. Self-handicapping refers to a student's pattern of excuse making and blame assessment for personal success or failure. Procrastination shares some characteristics with self-handicapping, but refers more directly to the temporal dimension of a student's unwillingness or inability to accomplish tasks when necessary. Participants ($N = 244$) were undergraduates in the State University of New York, Geneseo psychology department's human subjects' pool.

The researcher used four predictor variables. Participants' college records contained their SAT scores and high school averages, both interval data. Wesley operationalized self-handicapping using Strube's 10-item Self-Handicapping Scale. The instrument's rating scales were 6-point Likert-type measures (1 = *certainly, always true*, 6 = *certainly, always false*). Five items from Solomon and Rothblum's Procrastination Assessment Scale (PASS) operationalized academic procrastination using 5-point Likert-type ratings

(1 = *never procrastinate*, 5 = *always procrastinate*). The criterion variable was cumulative college GPA at the end of the semester.

Significant intercorrelations ($p < .01$), computed separately for males ($n = 55$) and females ($n = 189$), were in the expected direction. High school average and SAT correlated positively with college GPA. Self-handicapping and procrastinatory behavior correlated negatively with college GPA. Forward multiple regression, conducted separately for males and females, produced different models. For males, high school average entered first, then procrastination, followed by SAT. The changes in R^2 were .34, .12, and .04, respectively. The final R^2 was .50. The model for females had SAT first, then procrastination, followed by high school average, with R^2 changes of .16, .10, and .03, respectively. The final R^2 for females was .29. The models for males and females, both significant at the .001 level, contained the same predictor variables but differed noticeably in variable weight and contribution. Procrastinatory behavior did contribute significantly to the prediction of college GPA. Self-handicapping did not contribute to the statistical explanation of college GPA.

Larson and Scontrino (1976) focused their investigative efforts on the prediction of cumulative graduation GPA using conventional academic and aptitude predictors. These researchers studied the relationship between three predictors and cumulative college GPA after graduation in four years. The goal was to evaluate the consistency of the predictors over an eight-year period with cross-validations in one- and five-year periods. The study participants were four-year graduates ($N = 1,457$) from a small West Coast university between 1966 and 1973.

The predictor variables for Larson and Scontrino's (1976) multiple regression analyses were high school GPA, SAT-Verbal score, and SAT-Math score. The criterion was cumulative college GPA at graduation. In addition to calculating regression equations for each year's combined sample, the researchers also calculated regression equations separately for males and females.

Larson and Scontrino's (1976) results indicated that high school GPA was consistently the strongest contributor to GPA prediction. The proportion of variance accounted for by the predictors (R^2) with SAT scores included was only 4.7% greater than using HSGPA alone across the eight samples. The multiple correlation coefficients were relatively stable over time. The one- and five-year cross-validations produced minimal shrinkage in the correlation coefficients. The inclusion of SAT scores in the cross-validation procedures for females resulted in minimal improvement or worsened predictive validity. These findings supported the use of high school GPA, or high school GPA with SAT scores, in predicting four-year cumulative graduation GPA.

Summary. High school GPA was the best predictor of cumulative college GPA (Wolfe & Johnson, 1995; Larson & Scontrino, 1976). Aptitude test scores, such as the SAT and ACT, consistently added predictive power to the equation. Personality measures made significant but inconsistent contributions. The statistical procedure most frequently employed was multiple regression. Still not satisfied with the level of accuracy resulting from conventional variables, many researchers attempted to wrest additional predictive power from the high school record.

High School Record as a Source of Additional Predictive Power

An alternative approach, in an effort to account for additional variance in college GPA, was Burnham and Hewitt's (1972) consideration of secondary grades in two formats. Burnham and Hewitt combined cognitive and non-cognitive predictors of college academic achievement in their study of Yale University students. They explored the relative impact of two different types of secondary school marking systems (letter grades and numerical grades) on the predictive validity of the secondary school record and the relative contribution of the secondary school record and SAT scores on college achievement. The sample consisted of 1,552 Yale University students in two successive freshman year groups who attended the same institution their final three years of high school. The researchers split the sample into two groups: numerical grades from high school ($n = 791$) and letter grades from high school ($n = 761$). SAT scores and freshman year GPA for the two groups were similar.

Burnham and Hewitt (1972) calculated zero-order Pearson correlations between sophomore, junior, and senior year secondary grades with SAT scores and freshman year GPA. Multiple regression yielded a multiple R between overall high school performance and freshman year GPA. The three predictors were sophomore, junior, and senior year secondary school average. Burnham and Hewitt computed the averages for the letter group as follows: $A = 95$, $B = 85$, $C = 75$, etc. The criterion variable was freshman year GPA.

The study findings consistently supported numerical grades as better predictors of freshman year GPA than letter grades. The Pearson r describing the relationship between sophomore, junior, and senior letter grades and freshman GPA was .32, .34, and .40,

respectively. The same correlations for numerical grades were .43, .43, and .49. After

adjusting with a school correction factor developed by Yale University to compare

different high school records, the correlations for both groups increased equally. The

adjusted correlations for the letter grade group were .40, .44, and .49. The adjusted

correlations for the numerical group were .51, .52, and .58.

Burnham and Hewitt's (1972) multiple regression analysis, with unadjusted secondary

performance as the predictors, produced a multiple R of .40 for the letter group and .45

for the numerical group. With the school correction factor and SAT scores included, the

multiple R for the letter group improved to .57; the numerical group improved to .62.

The researchers concluded that the two different secondary marking systems, letter and

numerical, contain different predictive validity and precision. The combination of

numerical grades, high school correction factor, and aptitude score produced the highest

multiple correlation.

To improve the predictive power of the high school record on college performance,

Chase and Jacobs (1989) performed multiple regression analyses comparing overall high

school GPA to academics-only high school GPA. By excluding potentially confounding

non-academic courses from the second analysis, the researchers expected an

improvement in the predictive validity of the equation. The sample ($N = 100$) consisted

of 48 females and 52 males entering Indiana University as freshmen in the fall of 1987.

Chase and Jacobs (1989) selected the following continuous predictor variables: (a)

SAT-Verbal score, (b) SAT-Mathematics score, (c) SAT-Total score, (d) high school

percentile rank in class, and (e) two measures of high school GPA. The first measure was

overall GPA including all courses taken. The second measure, academic GPA, included

only those high school courses taken in mathematics, computer science, English, foreign languages, history, social sciences, and all natural and physical sciences. The criterion was college freshman GPA at the end of the first semester.

Correlational analysis revealed academic GPA ($r = .57$) was more highly associated with college GPA than overall high school GPA ($r = .52$). The first multiple regression computation, using SAT scores, rank in class, and academic GPA as predictors, produced a multiple R of .61 ($R^2 = .37$) with academic GPA and SAT-Total score as the significant predictors. The second multiple regression computation, substituting overall high school GPA for academic GPA, produced a multiple R of .60 ($R^2 = .36$) with rank in class and SAT-Total score as the significant contributors. The proportion of variance explained by each equation, .37 and .36, indicated little benefit was achieved from the time invested in interpreting high school transcripts to produce academic only GPAs.

Research by Sockloff, Ebert, and Degnan (1973) attempted to improve the predictive efficiency of preadmission data on college grade point average (GPA) by adjusting the prediction equation for characteristics of individual, large feeder high schools. The researchers theorized that prediction would improve with equations tailored to specific secondary institutions. The participants were full-time freshmen ($N = 1,435$) who entered Temple University (TU) in the fall semesters of 1965 ($n = 849$) and 1969 ($n = 586$) from 11 feeder high schools. The 1965 freshmen provided data for the regression calculations. The 1969 group provided cross-validation information.

The predictor variables, measured at the interval level, were SAT-Verbal score, SAT-Mathematics score, and high school quintile. The criterion was second semester cumulative college GPA. The researchers computed three prediction equations for each

student's GPA using multiple regression procedures. The nonweighted traditional method used one formula to predict GPA for all students. The multiple formula method produced separate prediction equations for each feeder high school and a predicted GPA for each student (MFPGPA). The weighted method adjusted the nonweighted predicted GPA for each student by a weighted value based on the performance of all graduates from one high school at TU (WPGPA). The weighted value was mean GPA divided by mean predicted nonweighted GPA for graduates of one high school. For the regression sample, MFPGPA ($r = .62$) was significantly ($p < .001$) more highly correlated with GPA than WPGPA ($r = .59$). WPGPA was significantly ($p < .001$) more highly correlated with GPA than the value obtained using the nonweighted traditional formula.

For the cross-validation subsample, Sockloff et al. (1973) reported MFPGPA and WPGPA were significantly ($p < .01$) better predictors than the traditional formula. Shrinkage occurred across all correlations from the regression to cross-validation subsamples. These results indicated that the prediction of college grades improved when equations included the relative mean success of fellow high school graduates. The weighted and multiple formula methods were superior to the nonweighted method.

Young and Barrett (1992) studied the ability of a student's high school program rigor to add power to the prediction of college grades and graduation. Their research sought to gain additional predictive utility from the high school record, beyond high school grade point average and rank in class, by assessing the average academic rigor (AVGRIGOR) of a student's high school program. The study participants were entering freshmen ($N = 91$) at a large mid-Atlantic state university in 1984 or 1985 who graduated from one local high school.

The interval-level predictor variables were SAT-Verbal score, SAT-Mathematics score, high school percentile, and AVGRIGOR. The researchers computed AVGRIGOR by multiplying high school grades (A = 4, B = 3, C = 2, D = 1, and F = 0) by difficulty level (advanced placement = 4, honors = 3, regular = 2, and remedial = 1) for all high school courses taken. AVGRIGOR was the average of these products. The criterion variables were cumulative college GPA and graduation status (0 = no, 1 = yes).

Correlation coefficients reported by Young and Barrett (1992) indicated AVGRIGOR was most highly correlated with cumulative college GPA ($r = .52$). Ordinary least-squares regression analysis using SAT-Verbal, SAT-Math, and high school rank in class yielded an R-square of .26. With AVGRIGOR included in the model, prediction improved by 26%. R-square was .32. Two logistic regression analyses, using the previous predictor variable combinations, indicated AVGRIGOR significantly ($p < .02$) improved prediction of degree completion. Young and Barret's results demonstrated that high school program rigor holds potential power in predicting college GPA and degree completion.

Summary. Pursuing untapped sources of predictive power within the high school record, beyond simple GPA or high school rank, researchers investigated many variables for utility in predicting college GPA. Numerical high school grades proved better predictors than letter grades (Burnham & Hewitt, 1972). An academic-only high school GPA only slightly improved prediction from an overall high school GPA (Chase & Jacobs, 1989). Adding a difficulty factor allowed Sockloff, Ebert, and Degnan (1973) to significantly improve their college GPA prediction equation. Finally, prediction equations tailored to specific high schools performed better than generic or weighted

formulas. These researchers found sources of predictive power within the college student's high school record, beyond GPA and rank in class, which significantly improved college grade prediction.

The Prediction of Persistence

Though similar to GPA prediction in many respects, persistence prediction proves to be a unique phenomenon (Perry, 1981). Institutional and personal variables affect individuals uniquely. Two important issues are definitions (e.g., stopouts, dropouts, dismissals, and persisters) and length of time considered in the study (Pantages & Creedon, 1978). Students leave institutions for a variety of reasons. Education professionals can improve retention rates by understanding the variables impacting student enrollment decision-making (Tinto, 1975). This section is subdivided into three parts: (a) background and theory, (b) predicting persistence to the sophomore year, and (c) predicting persistence beyond the sophomore year.

Background and Theory

Pantages and Creedon (1978) summarized 25 years of research, 1950 to 1975, on college attrition. The reviewers included discussions on methodological criticisms, attrition-related variables, withdrawal procedures, and proposed programs for countering attrition from 135 sources. Criticisms of past attrition studies included too heavy a reliance on the relationship between achievement and persistence, the lack of comparison groups, the inclusion of too few variables, ex post facto methodology, and not enough longitudinal studies.

A persistent problem with comparing attrition studies was definitions. Researchers and universities uniquely defined "dropout," "stopout," "attrition," and "persistence."

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Compounding this problem, studies rarely followed participants outside the institution. A "dropout" from one college could graduate from another institution. Conclusions based on this partial data could reflect institutional attrition but not student persistence. One important distinction, made in several studies, was the difference between "voluntary" withdrawals, students leaving for their own reasons, and "nonvoluntary" dismissals, students dismissed for poor grades. Defining terms and developing a conceptual model of attrition, such as Tinto's (1975) model of college dropout, were key steps toward better understanding college student persistence and attrition.

Pantages and Creedon (1978) cited the following conclusions regarding average college attrition rates: (a) fifty percent of entering freshmen will leave an institution within four years without a degree, (b) forty percent of entering freshmen will graduate within four years, (c) the remaining ten percent will graduate after four years, and (d) two-fifths of the leavers will graduate from another institution. These proportions held relatively stable over the preceding decades.

Study results were not consistent on variable effects. Pantages and Creedon (1978) categorized variables into demographic, academic, motivation, personality, college environment, or financial categories. The demographic factors were age, sex, socioeconomic status, hometown location and size, and size and type of high school. The academic factors were high school grade point average and rank, scholastic aptitude measures, college GPA, and study habits. The motivational predictors included commitment, reasons for attending college, vocational and occupational goals, educational interests, parental influence, and peer-group influence. Personality variables included numerous personality traits and characteristics (i.e., values, self-sufficiency,

maturity, and self-confidence). The college environment factors were size, housing, extracurricular activities, student-faculty relationships, and peer relationships.

Student-reported reasons for withdrawal varied by institution type, dropout type, academic history, and years of college completed. Dropouts' responses provided information on the process of withdrawal, from who they talked to, what they talked about, the reaction they received, and when they dropped out or returned. Successful anti-attrition programs, less frequently reported on than statistical studies on attrition rates, focused on intervention. Pantages and Creedon (1978) made the following recommendations for successful anti-attrition programs: (a) be proactive and focus on freshmen; (b) implement comprehensive orientation programs; (c) widely publish counseling services to students, family, and faculty; (d) invest in vocational counseling and job development; (e) teach study habits; (f) assess the college environment for contributing factors; (g) provide grants when possible; (h) enhance and maximize student-faculty interaction; and (i) require exit interviews and follow-up questionnaires for dropouts.

In a 1975 article, Vincent Tinto described his theoretical model of college dropout behavior. Tinto began with an overview of the two major shortcomings of past retention and dropout studies. The weaknesses were inadequate attention to definitions and an unbalanced focus on theoretical models seeking to explain variance rather than descriptive models seeking an understanding of the process.

Tinto's model of college dropout was descriptive. Based on Durkheim's theory of suicide, which proposes individuals are more likely to commit suicide if insufficiently integrated into the fabric of society, Tinto's model centered on the student's academic

and social integration into the fabric of the university, equating dropout from the university to dropout from society. A student's family background, individual attributes, and pre-college schooling experiences influence goal commitment and institutional commitment. Both commitment factors impact performance in the academic system (grade performance and intellectual development) and in the social system (peer-group and faculty interactions). Those outcomes determined academic and social integration. Integration related back to goal and institutional commitment. Dropout decisions were directly influenced by goal and institutional commitment level. External factors impacted the model, but only from the student's perspective of how it affected goal and institutional commitment.

Tinto (1975) expounded on specific variables needed to transform his descriptive model into a theoretical, predictive model. Family background variables included socioeconomic status, parents' educational attainment, and home environment. Individual attribute variables included academic aptitude, personality traits, sex, and race. Pre-college schooling variables included high school grade point average, rank in graduating class, and the characteristics and environment of the student's high school. Tinto supported past researchers' conclusions that goal commitment, paired with ability and family variables, was a powerful discriminator between persisters and leavers.

The key components of Tinto's (1975) longitudinal model of college dropout were the student's social and academic integration into the fabric of the university. All variables contributed to integration; integration directly influenced dropout decisions. Tinto defined social integration as occurring primarily through informal peer group associations, semi-formal extracurricular activities, and interaction with faculty and

administrative personnel. Academic integration's operationalization occurred through grade point average and intellectual development. Tinto's theory of college dropout addressed the weaknesses he found in earlier retention studies, assimilated prior research findings, described the process and the variables from pre-enrollment through dropout decision, and provided a framework for future research. The following studies explored these college student persistence issues from a variety of perspectives.

Predicting Persistence to the Sophomore Year

Cabrera, Castañeda, Nora, and Hengstler (1992) examined the convergent and discriminant validity between Tinto's (1975) Student Integration Model and Bean's (1980) Student Attrition Model. Tinto's model focused on a student's integration into the social and academic systems of the institution. Bean's model addressed some integration factors, but included external, environmental variables in the attrition model. The study participants ($N = 466$) were traditional, first-time, full-time, unmarried freshmen entering a large southwestern urban postsecondary institution in the fall of 1988.

Cabrera et al. (1992) followed a longitudinal research design. During the participants' freshman spring, the investigators mailed a 79-item questionnaire to 2,453 students and received 466 usable responses (19% response rate). The 79-item instrument measured the following ten constructs needed to test both models' predictive validity: (a) intent to persist, (b) family approval, (c) institutional fit, (d) courses, (e) encouragement of friends, (f) opportunity to transfer, (g) academic integration, (h) social integration, (i) institutional commitment, and (j) goal commitment. The researchers recorded college GPA at the end of the freshman year and enrollment status at the beginning of the sophomore year (fall 1989). A three-stage strategy using Linear Structural Equation Models (LISREL 7)

culminated in a comparison of the two models. First, the researchers examined the factor loadings and unique variances of each model to control for nuisance variables and test for construct validity. Second, the predictive validity of each model was assessed separately. Finally, the research design required an examination of the two models' convergence.

The results of the LISREL analysis indicated that Bean's (1980) model accounted for 44% of the variance in persistence. Tinto's (1975) model accounted for 38% of the variance in persistence. Three external factors from Bean's model (parental encouragement, support from friends, and finances) accounted for the improvement over Tinto's model. Significant overlap existed between both model in regards to variables measuring student integration, commitment, and involvement in the institution.

Terenzini and Pascarella (1977) assessed the validity of Tinto's (1975) theory of student attrition. The study participants were randomly-selected freshmen ($N = 500$) at Syracuse University in the College of Arts and Sciences. Participants received mail surveys in March 1975. The response rate was 75.8% ($n = 379$) with no response bias. As of September 1975, 313 of the 379 were still enrolled. The researchers randomly selected 60 participants for data analysis, retaining 253 for cross-validation.

Participants rated two statements on the Adjective Rating Scale (ARS). The two statements were "I have found my academic program at S.U. to be:" and "I have found my nonacademic life at S.U. to be:." The ARS contained 24 adjectives. Participants recorded their responses on a four-point scale (1 = *extremely*, 4 = *not at all*). Factor analysis on the data revealed the following five factors: (a) Interest Value, (b) Dullness/Apathy, (c) Practical Appeal, (d) Difficulty/Challenge, and (e) Uniqueness.

Test-retest reliability coefficients over a seven week period ranged from .66 to .98. Coefficient alpha for the scales ranged from .71 to .85.

Terenzini and Pascarella (1977) executed separate principal-components analysis procedures with varimax rotation for each question. The resultant seven factors were the predictor variables in separate multivariate analyses of variance (MANOVA) and stepwise discriminate analyses. The four factors for "academic program" were interest value, dullness/apathy, practical appeal, and difficulty/challenge. A fifth predictor, cumulative GPA, was included. The three factors for "non-academic life" were interest value, demand/challenge, and practical appeal. Two additional factors, informal interaction with faculty and number of extracurricular activities, were included. Factors were combined in a third discriminant analysis. The criterion variable was enrollment status.

Academic integration predictors differentiated leavers from stayers at the .01 level of significance. The social integration predictors differentiated leavers from stayers at the .001 level of significance. The discriminant analysis using a combined variable set predicted enrollment status at the .001 level of significance. Terenzini and Pascarella's results supported Tinto's (1975) theory of student attrition. Academic and social integration constructs were significantly related to voluntary student attrition.

Pascarella and Terenzini (1980) again tested the predictive validity of Tinto's (1975) theoretical model of college dropout on a new class of freshmen at Syracuse University. The researchers attempted to discriminate between persisters and dropouts using a measure designed to assess Tinto's two theoretical constructs, academic and social integration. Incoming freshmen ($N = 763$) at Syracuse University in the fall of 1976 were

the study participants. A mailed questionnaire in the summer prior to classes recorded

background information and expectations. A mailed questionnaire in the spring

contained 34 Likert-type items with 5-point scales (5 being more favorable than 1)

focused on Tinto's institutional integration issues. The sample was split into two groups

($n_1 = 497$ and $n_2 = 266$). The smaller group was used for cross-validation.

Pascarella and Terenzini controlled for the following variables: (a) sex, (b) race, (c)

program of enrollment, (d) SAT score, (e) high school percentile class rank, (f) number

of high school extracurricular activities, (g) expected number of informal contacts with

faculty, (h) parents' combined annual income, (i) parents' formal education, (j) expected

degree, (k) importance of college graduation, (l) choice in attending university, (m)

confidence in school choice, (n) freshman cumulative grade point average, and (o)

college extracurricular activities. The dependent variable was persistence/dropout status

after the freshman year.

Principal components factor analysis on the 34 questionnaire items yielded five scale

factors. They were Peer-Group Interactions, Interactions with Faculty, Faculty Concern

for Student Development and Teaching, Academic and Intellectual Development, and

Institutional/Goal Commitments. A multivariate analysis of covariance (MANCOVA),

adjusted for the covariates, revealed significant ($p < .001$) differences between the five

institutional integration scales. Discriminant analysis, with all control variables entered

setwise, indicated all scales factors significantly ($p < .001$) contributed to the prediction

of persister/dropout status at the univariate level. Three factor variables

(institutional/goal commitments, interactions with faculty, and faculty concerns for

students) were the strongest contributors and significant with all variables entered in the

model. Using the five scale factors, Pascarella and Terenzini (1980) correctly classified 79.5% of the calibration group and 78.5% of the cross-validation group, significant improvement over chance at the .001 level. Control variables improved predictability by approximately three percent. This research, based upon Tinto's model of college dropout, supported the importance of social and academic integration in students' decision to persist or dropout.

Research by Pascarella, Duby, Miller, and Rasher (1981) studied the determinants of freshman year persistence at an urban, nonresidential university. Building upon prior retention research but focusing on a unique environment, the urban, nonresidential university, the researchers attempted to discriminate between persisters, stopouts, and withdrawals using preenrollment variables in a longitudinal design. The sample population was entering freshmen in the fall semesters of 1976 ($n = 1,055$) and 1977 ($n = 879$) at the University of Illinois, Chicago Circle (UICC).

Persisters were students continuously enrolled through the first semester of their sophomore year. Stopouts missed one or more quarters of their freshmen year but were enrolled during the first semester of their sophomore year. Withdrawals missed one or more quarters of their freshmen year and were not enrolled their sophomore year. The predictor variables considered by Pascarella et al. (1981), collected on the Cooperative Institutional Research Program (CIRP) survey, were age, high school GPA and rank, college choice, perceived need for remedial help, parents' total income, sex, race, college of enrollment, ACT composite score, parents' education level, highest expected degree, and the perceived likelihood of the following events: (a) failing one or more courses, (b) joining a social organization, (c) needing extra time to complete a degree, (d) working,

(e) stopping out, (f) dropping out, and (g) transferring. Two college performance

predictors were credit hours and GPA earned during the first quarter of the freshman

year. The investigators used three-group discriminant function analysis to predict

membership. The first analysis proceeded setwise with the preenrollment variables

followed by college performance variables. The second analysis proceeded stepwise for

the preenrollment variables, followed by the college performance variables. The 1977

cohort was the calibration sample. The 1976 cohort was the validation sample.

Results from both analyses indicated significant ($p < .001$) prediction of group

membership. Both models accounted for approximately 20% of the variance in the

dependent variable. First quarter GPA was a significant predictor in both analyses.

Equation 1, composed of nine preenrollment variables only, correctly classified 48.1% of

the validation sample. Equation 2, adding first quarter GPA to Equation 1, correctly

classified 56.7% of students. Both equations were significant ($p < .001$) improvements

over chance (.333). Withdrawals were the most difficult group to predict using

preenrollment variables. With the inclusion of first quarter GPA, withdrawal prediction

improved 30%. Freshman persistence at an urban, nonresidential university showed a

significant relationship to preenrollment variables. First quarter GPA, an indicator of

integration into the academic structure of the institution, was a powerful contributor to

the prediction equation.

Haislett and Hafer (1990) examined the effect of career indecision on predicting

persistence. Their first study focused on 114 freshman students enrolled in the Freshman

Engineering Program at a medium-sized, southeastern university. Their second study, a

replication study on 317 freshmen in the same program the following year, confirmed

their results. The purpose of the study was to investigate students' career indecision associated with their successful completion of the first year in the engineering program.

Independent variables were SAT-Verbal score, SAT-Quantitative score, SAT-Total score, predicted grade point ratio (PGPR; a university specific measure composed of the highest reported SAT-Verbal score, highest reported SAT-Quantitative score, and a cumulative class ranking at the time of admission weighted three times the SAT scores), and eight career indecision factors. The career indecision variables, computed from each student's completion of the Career Decision Scale (CDS), were: (a) overall career decisiveness, (b) career choice decisiveness, (c) academic major choice decisiveness, (d) overall career indecision, (e) career structure and confidence indecision, (f) external barrier indecision, (g) approach-approach indecision, and (h) personal conflict indecision. The nominal-level dependent variable was 'success' or 'failure' completing the first year of the program. Success was defined as completing two semesters of the program with a grade point average at or above 2.0 on a 4.0 scale.

Multiple regression analysis provided researchers with an algorithm to predict successful academic completion of the first year in the engineering program. Specifically, PGPR and three CDS variables combined to provide the best predictive value. Haislett and Hafer's resultant algorithm contains two question steps: (a) Is the student's PGPR above 2.4, the mean PGPR for the sample?, and (b) Is the student's average response on the three CDS factors above 5.0, the midpoint of possible scores when combining the three factors? A 'yes' to either or both questions predicted successful completion. A 'no' to both questions predicted academic failure. This algorithm correctly predicted student success or failure 78% of the time the first year,

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compared to 72% for PGPR alone, 69% for SAT and career factors, and 59% for SAT alone. The second year validation study's results were similar with 76% correct prediction, compared to 68%, 75%, and 64% for their respective categories. Career indecisiveness variables added predictive power to the SAT and PGPR, traditional indicators of academic success. PGPR was a better predictor than SAT alone. PGPR combined with the career factor was a more accurate predictor than SAT combined with the career factor.

Summary. Researchers investigated two models of college student retention decision making. Three studies provided evidence supporting Tinto's model of college dropout. Bean's Student Attrition Model, which incorporated environmental factors not considered by Tinto, correctly classified students as persisters or dropouts better than Tinto's model (Cabrera, Castañeda, Nora, & Hengstler, 1992). A career indecision measure assisted with discrimination of academic success (Haislett & Hafer, 1990). Working at a metropolitan, urban university, Pascarella, Duby, Miller, and Rasher (1981) successfully discriminated stopouts, persisters, and withdrawals using demographic variables and first term GPA. Researcher used discriminant analysis to predict student membership in a group. Though most persistence studies focus on the critical first year of college, an understanding of the variables associated with retention beyond the sophomore year is of considerable value to university administrators, faculty, and researchers.

Predicting Persistence Beyond the Sophomore Year

A 1988 study by Boyer and Sedlacek investigated the validity of noncognitive variables as predictors of retention for international students. The researchers used the Noncognitive Questionnaire (NCQ), originally designed by Sedlacek and Brooks (1976)

to predict academic success for minority students. The participants, entering freshmen (N = 248) at a large, eastern state university in the fall of 1981, completed the 23-item NCQ during orientation. The sample was one-third men, one-third immigrants, and from the following regions: Asia or Southeast Asia (39%), Latin America (15%), Africa (15%), the Middle East (11%), and other areas (20%)

The NCQ contained two nominal items, 18 items measured on a Likert-type scale, and three open-ended questions. Median test-retest reliability was .85 for all items. Principal components factor analysis demonstrated support for the following eight, interval-level noncognitive predictors originally reported by Sedlacek and Brooks (1976): (a) Leadership, (b) Recognizing Racism, (c) Preference for Long-range Goals, (d) Realistic Self-appraisal, (e) Support for College Plans, (f) Self-confidence, (g) Community Service, and (h) Knowledge Acquired in a Field. The predictor variables for the stepwise multiple regression and stepwise multiple discriminant analyses were the eight NCQ variables. The nominal variable enrollment status, measured each semester during the participant's first eight semesters at the university, was the criterion for the eight discriminant analyses. Grade point average (GPA), measured at each semester of the eight semesters, was the dependent variable for the multiple regression analyses.

Boyer and Sedlacek (1988) reported community service and understanding racism were the most significant ($p < .05$) predictors of persistence across all eight semesters. Community service was the best predictor for four separate semester equations. The percentage of students correctly classified as persisters or non-persisters ranged from 75% after one semester to 63% after six semesters. On average, seven NCQ variables significantly contributed to each semester's prediction equation. Self-confidence and

support for college plans were the strongest predictors of GPA for each semester. On average, three NCQ variables significantly contributed to each semester's GPA prediction equation. Boyer and Sedlacek's findings indicated unique sets of noncognitive predictors for persistence and grade point average among international students.

Levin and Wyckoff (1995) also considered the impact of noncognitive variables in their study on student persistence in an engineering program. The researchers focused on identifying cognitive and noncognitive variables with predictive potential for improving retention. The study sample ($N = 1,043$) was entering engineering freshmen at a large mid-Atlantic research university in 1991.

Three logistic regression models used 19 independent variables to predict the odds of a freshman engineering student being accepted into an engineering program as a junior. The 19 variables included ten cognitive and nine noncognitive measures. The continuous cognitive measures were: (a) high school GPA, (b) SAT-Math, (c) SAT-Verbal, and (d) algebra and chemistry university placement test scores. Five nominal cognitive predictors were grades in the following college courses: (a) Calculus I, (b) Calculus II, (c) Physics I, (d) Physics II, and (e) Chemistry I. The nominal noncognitive predictors were gender, attitude toward high school math, physics, and chemistry (like, dislike), reason for engineering choice (genuine, superficial), certainty about major, and knowledge of intended major (accurate, inaccurate). Two continuous noncognitive predictors were anticipated college study hours and a measure of interest in science.

Levin and Wyckoff (1995), using .05 as the significance level for variable entry into the equation, calculated one logistics regression model using information available upon enrollment (Model I), one model with all information available following the freshman

year (Model II), and one model with all information available following the sophomore year (Model III). The significant ($p < .05$) predictors in Model I were high school GPA, placement test scores, gender, science focus, and reason for choosing engineering. College course grades in physics, calculus, and chemistry were the only significant predictors in Models II and III. The results of Levin and Wyckoff's (1995) study highlighted the dynamic nature of persistence, college performance, and the need to tailor prediction models for students at different points in their educational careers.

Lewallen (1993) also explored the relationship between college students' major, career decision status, and persistence. Based upon the contradictory nature of past research in this area, Lewallen hypothesized that knowing a student is "undecided" on major selection at college entrance is insufficient to classify that student as at-risk of leaving. The sample came from the Higher Education Research Institute's (HERI) Cooperative Institutional Research Program (CIRP). The CIRP followed a national cohort of 27,064 freshmen entering college in 1985, with a follow-up four years later. Lewallen's final sample (n = 18,461) contained only those freshmen with complete data and a goal of at least a bachelor's degree.

The independent variables of interest were six dichotomous measures of college major indecision (yes, no), career choice indecision (yes, no), and the four possible combinations of decision/indecision on those two topics. Lewallen (1993) employed 27 control variables implicated in previous studies as persistence predictors. Nineteen nominal, dummy-coded variables accounted for gender, race, university type, enrollment type, living arrangements, involvement in student government and faculty research, honors courses, and employment. The eight continuous control variables were: (a) age,

(b) parental income, (c) father's educational level, (d) mother's educational level, (e) socioeconomic status, (f) high school grades, (g) degree expectation, and (h) college grades. The criterion was persistence over four years (2 = completed bachelor's degree or four years of study, 1 = all others). Lewallen used ordinary least-squares multiple regression to assess each variable's contribution to the prediction of persistence.

Lewallen's (1993) results supported the hypothesis. The researcher entered the predictor variables hierarchically, based on the time sequence of occurrence, into the regression stepwise using $p < .01$ as the significance level for variables to enter the equation. Fourteen variables were significant ($p < .01$) predictors of persistence. The best predictors, with their respective standardized regression coefficients in parentheses, were full-time enrollment (.24), college grades (.15), private school (.14), four-year school (.14), and on-campus housing (.12). The linear combination of the significant predictors (R^2) accounted for 24% of the variance in persistence, significant at the .001 level. None of the six variables of interest, focused on major and career indecision at college entrance, entered the regression equation as significant predictors of persistence.

Summary. A review of retention studies provides evidence for three conclusions. First, retention is a complex process, including a student's academic and social integration into the fabric of the university (Tinto, 1975; Cabrera, Castaneda, Nora, & Hengstler, 1992). Bean's model of student attrition, using a wide variety of institutional, environmental, and performance variables, accounted for 44% of the variance in student persistence decisions. Second, traditional predictors are significantly associated with the length of a student's postsecondary career. Pre-enrollment performance variables accounted for 20% of the variance in students' decision to stay or leave (Pascarella,

Duby, Miller, & Rasher, 1981). Finally, noncognitive, demographic, and cultural factors contributed to students' decisions to stay at one institution or leave (Lewallen, 1993; Haislett & Hafer, 1990). The prediction of college GPA and persistence lead toward the ultimate goal, graduation.

The Prediction of Graduation

Compared to grades and retention, graduation status is farther removed from the traditional predictors of high school performance and aptitude test scores. Graduation rates and time to graduate are criterion variables researchers, institutions, and policymakers are interested in better understanding (Clarkson & Roscoe, 1993). Research designs incorporate a wide variety of variables in attempts to further shrink the unaccounted variance associated with graduation. Preenrollment variables include high school GPA, high school rank in class, aptitude test scores, demographic information, and attitudinal data (Ansley & Forsyth, 1983). Postenrollment variables include college GPA and major (Fletcher, Halpin, & Halpin, 1999).

A study by Clarkson and Roscoe (1993) investigated the differences between students who graduated in four years and those who graduated later. The researchers analyzed the differences to determine whether reasons for prolonged attendance were attributable to personal characteristics, institutional factors, or a combination of both. Study participants were graduates ($N = 1,587$) from the entering class of 1982 at a large comprehensive public university.

Data collection for predictor variables occurred in three steps. Interval-level institutional data for the entire sample included: (a) high school GPA, (b) ACT-Composite, -English, and -Mathematics scores (ACT, ACT-E, and ACT-M); (c) college

degree earned (nominal); (d) college credits earned at graduation; and (e) college GPA at graduation. Interval-level survey data from 264 randomly selected graduates (57% response rate) included: (a) first semester college GPA, (b) average number of credits taken per semester, (c) number of credit hours in withdrawn courses, (d) number of credit hours in incomplete courses, (e) number of credit hours in repeat courses, and (f) number of credit hours earned other than on-campus. A second survey of 461 graduates (57% response rate) provided primarily categorical data: (a) sources of college financial support, (b) parents' education, (c) involvement in college cocurricular activities, (d) employment status during college, (e) number of semesters attended (interval), (f) factors contributing to graduation in four years or more, (g) contact and satisfaction with academic advisors, and (h) number of times changed major. The criterion was time required to graduate from first enrollment.

Data analysis included a correlation matrix for all variables, chi-square analysis for frequency data, and analysis of variance for score variables. Comparisons were between students graduating in four years to students requiring more than four years. A greater percentage of females than males graduated in four years. A greater percentage of business majors than education major graduated in four years. Students graduating in four years had higher high school GPAs, higher first semester college GPAs, higher GPAs at graduation, more credits completed per term, fewer withdrawn or repeated courses, and completed more than 128 credit hours. Females with higher high school and college GPAs were more likely to graduate on time, take more credits per semester, and graduate with more than 128 credit hours. Variables associated with males' four-year graduation were higher ACT scores, a major in business administration, likelihood to

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withdraw from or repeat courses, and participation in intramural or intercollegiate sports. Employment history and advising services were not associated with significant differences in time to graduate.

The majority of variables associated with time to graduate were personal factors. Institutional factors, such as closed courses and conflicting offering times, affected students' schedules and academic programs. Clarkson and Roscoe (1993) recommended five steps for institutions to address barriers to on-time graduation: (a) periodic updates and informational sessions for academic advisors, (b) early academic advising for entering freshmen, (c) advising for students considering a course withdrawal, (d) improved communication between units to reduce course conflicts, and (e) increased offerings for high demand courses.

An investigative study by Lunneborg (1977) assessed aptitude, achievement, and interest measures for long-term ability to predict college graduation, cumulative grade point average (GPA), credits earned, and graduating major. The researcher's focus was on predicting graduating major, a criterion traditionally beyond predictive capabilities. The study participants were freshmen (N = 1,633; 55% male, 45% female) who entered the University of Washington in the fall of 1971 and persisted to graduation in spring 1975. Participants completed the Washington Pre-College (WPC) battery in their junior year of high school.

Interval-level WPC predictor variables included achievement measures of high school GPA in seven areas (English, mathematics, natural science, social science, foreign language, electives, and overall), 15 aptitude variables (seven verbal test scores, six quantitative test scores, spatial ability test score, and mechanical reasoning test score),

and eight interest scores based on Roe's occupational classification system. Age, sex, and an interest differentiation measure were also predictors. The study included 20 criterion variables: (a) graduation status, (b) cumulative GPA, (c) credits earned, (d) seven Roe major groups, and (e) ten fields of study. The researcher used stepwise multiple regression analyses in which predictors were tested for significant ($p < .05$) contribution in accounting for criterion variance.

Lunneborg's (1977) correlation analysis revealed high school GPA was the best predictor of graduation in four years ($r = .23$), cumulative GPA ($r = .51$), and total credits earned ($r = .23$). Stepwise multiple regression added little accountability for variance above high school GPA's contribution. The multiple R for graduation in four years was .25, .57 for cumulative GPA, and .24 for credits earned. The multiple regression analyses for nonacademic criteria yielded low multiple R values. The high and low multiple R values for predicting Roe major groups were .36 for technical majors and .12 for service majors. The high and low multiple R values for predicting field of study were .37 for engineering and .14 for architecture. High school GPA's significant correlations with multiple college academic achievement measures justified its continued use as a primary admission criteria.

Ansley and Forsyth (1983) investigated the relationship between academic success, graduation from college, achievement test scores on the Iowa Tests of Basic Skills (ITBS), and the Iowa Tests of Educational Development (ITED). Participants were 1997 graduates of Iowa high schools who entered the University of Iowa as freshmen in the fall of 1977. The predictor variables were: (a) ITED scores for four years of high school for Vocabulary, Expression, and Quantitative subtests, a Reading Total score, and a

Composite score; (b) ITBS scores for grades 4, 6, and 8 with Vocabulary, Reading, Language, Mathematics, and Composite categories; (c) ACT-Composite, English, and Mathematics scores; and (d) cumulative high school GPA. The criterion variables were first semester college GPA, college GPA, and graduation status as of December, 1982.

For all measures, the correlations between test scores and college GPAs, first semester and as of December, 1982, increased as the testing time approached high school graduation. The highest correlation for ACT, using the Composite, to first semester college GPA was .45. The ITED Composite score for 12th graders was a better predictor at .50. ACT-Composite was correlated to final college GPA at .44. Again, the ITED composite for high school seniors was more highly correlated at .49. Finally, college graduate/non-graduate status, using point biserial correlation coefficients, was best predicted by the ITED 12th grade composite with a .29 correlation. The ACT's highest correlation, using Mathematics Usage, was .24.

Elementary and secondary school achievement tests, such as the ITBS and ITED, were significantly related to first semester college GPA, college GPA after five and a half years, and graduation status. Correlations between achievement test scores and the three criterion variables generally increased with grade level. An achievement test component, ITED Composite for high school seniors, bettered any ACT score in predicting the three criterion measures.

Fletcher, Halpin, and Halpin (1999) also examined pre- and post-enrollment data for predictive validity. Their research focus was on the identification of students who advanced to a major in engineering. A second focus of the study was determining whether any single predictor could identify students likely to graduate with another

major. Participants were freshmen ($N = 868$) enrolled in the pre-engineering curriculum at Auburn University (AU) in 1991. Data collection occurred over seven years.

The researchers identified six categories of students: (a) advancers to a major in the engineering program, (b) non-advancers with good grades (GPA 2.2), (c) non-advancers with poor grades (GPA < 2.2), (d) graduates in the College of Engineering, (e) graduates in another AU school or college, and (f) non-graduates. The criterion variables were engineering status (first three categories above) and graduation status (last three categories above). The interval-level predictor variables were high school math index, high school science index, high school humanities index, high school grade point index, AU grades for 15 individual courses in the pre-engineering curriculum, and first quarter college GPA at AU. The nominal predictor was sex.

Three-way analyses of variance (ANOVA) were followed by Fisher's LSD test when indicated. The ANOVA for the engineering status groups revealed significant differences on high school math, science, humanities, and grade point indices. The strongest relationship with engineering status was first quarter college GPA. Three-way ANOVAs among the graduation status groups revealed similar results. All high school indices yielded significant differences between groups. The single strongest relationship with graduation status was first quarter college GPA. The 15 individual course grades earned in the pre-engineering curriculum were all significantly correlated with the high school indices. The highest correlations existed between the individual course grades and first quarter college GPA. First quarter college GPA yielded an Eta of .639 for advancement to an engineering major and .454 for graduation with an engineering major, the strongest relationships in the study.

Summary.

Graduation status, similar to grade point average, is best predicted by high school performance measures such as GPA and achievement tests (Lunneborg, 1977; Ansley & Forsyth, 1983). If college variables are available, such as freshman GPA, cumulative GPA, or major, these postenrollment variables carry significant contributions for the prediction of graduation. Demographic and personal variables impact each gender uniquely (Clarkson & Roscoe, 1993).

Prediction with Nontraditional Students

Nontraditional students constitute a significant portion of the college student population (Baker & Velez, 1996). Students attending part-time, working parents, adult learners, and students admitted with scores below the college minimum entrance requirements are an increasingly large segment of the college education market. Each subgroup is potentially affected, and predicted, by a unique set of circumstances different than those faced by the traditional full-time student body. Some of the nontraditional populations of students studied by researchers include specially admitted students (Ting, 1977), athletes (Sedlacek & Adams-Gaston, 1992), first-generation students (Riehl, 1994), and community college students (Fralick, 1993). The criteria and statistical analyses remain the same as with the traditional population of students. The researchers focused on identifying the predictors unique to each population of nontraditional students to account for the maximum percentage of variance in college performance. This section is subdivided into the following parts: (a) technical/vocational/community college students, (b) student athletes, and (c) at-risk students.

Technical/Vocational/Community College Students

An investigational study by Taube and Taube (1990) examined the interrelationships between multiple predictor variables of success in a technical postsecondary institution. The study compared pre- and post-enrollment factors' predictive validity of initial and subsequent achievement for predominantly nontraditional students. Participants were full-time students ($N = 127$) at an accredited two-year technical college in Louisiana. The sample was 46% Black, 56% female, and 20% unwed mothers. Participants completed a post-enrollment survey.

The pre-enrollment predictors were gender (male = 1, female = 0), age, race (White = 1, non-White = 0), marital status (yes = 1, no = 0), unwed mother (yes = 1, no = 0), diploma type (high school diploma = 1, GED = 0), transportation mode (own car = 1, car rider = 2, bus rider = 3), entrance exam score, and expected GPA. Interval-level post-enrollment predictors were weekly work hours, absences, first quarter GPA, goal commitment, student interaction, and faculty interaction. The researchers employed linear regression to predict first quarter GPA and second quarter GPA.

Taube and Taube (1990) reported an adjusted R-square value of .40 for the first quarter GPA ($n = 127$) regression equation. The significant ($p < .05$) pre-enrollment predictors were race, gender, and entrance exam score. White females with higher entrance scores were associated with higher grades. One post-enrollment predictor, absences, was a significant contributor. Diploma type and expected GPA were significant at the .10 level. The second quarter GPA ($n = 96$) prediction equation indicated the following three post-enrollment predictors as significant ($p < .05$) contributors: (a) work hours, (b) first quarter GPA, and (c) goal commitment. Gender

and diploma type were significant at the .10 level. The investigators uncovered no relationship between GPA and unwed mother status, age, or marital status. Results provided practitioners with empirical support for the validity of entrance exams and the importance of goal commitment for nontraditional students at a technical postsecondary institution.

Continuing this examination of performance prediction at vocational or technical schools, Tan (1991) explored the relationship between entering grade point average and academic performance at a health-related institution. The study participants ($N = 1,256$) were students entering Palmer College of Chiropractic between 1984 and 1987. The entrance requirement for this nontraditional institution was two years of college-level work with a minimum 2.25 GPA. Some applicants completed two years of community college. Others entered Palmer College with a bachelor's degree. The minimum GPA, therefore, reflected different levels and amounts of college work for each applicant. Tan's research sought to establish the predictive validity of the entering GPA in this environment.

Tan (1991) employed a one-way analysis of variance (ANOVA) to investigate the relationship between entering GPA and earned GPA at the institution. The independent variable, entering GPA, was reduced to the following nominal quartiles: (a) first quartile = 2.59 or lower, (b) second quartile = 2.60 – 2.88, (c) third quartile = 3.00 – 3.48, and (d) fourth quartile = 3.49 - 4.00. The dependent variable, earned cumulative GPA at the institution, was interval-level. The result ($F = 127.0049$) was significant at the .001 level. Post hoc analysis revealed that the mean earned GPA for each level of the independent variable was significantly different from the other means ($p < .001$). Tan's results

indicated that, regardless of the diverse nature of students' prior postsecondary preparation, entering GPA was a significant predictor of academic performance at the institution.

Fralick (1993) investigated attrition at a community college. Dropouts, students leaving the institution before earning a degree, are frequently labeled failures, as opposed to successful graduates. Fralick randomly selected dropouts ($N = 1,000$) from the Cuyamaca College student population in 1990 who did not return for classes in the spring of 1991. Participant responses were recorded during a telephone survey.

Fralick gathered categorical data on the following variables: (a) personal feeling of success or failure regarding educational goals, (b) reason(s) for leaving college, (c) employment history during classes and after attrition, (d) problems associated with continued college attendance, (e) goals or major, (f) satisfaction with the college experience, (g) gender, and (h) ethnicity. Interval data included age, course load, high school GPA, and college GPA.

Descriptive statistics highlighted differences between the 78% of non-returning students considering themselves successful (positive attrition) and the 22% of non-returning students considering themselves unsuccessful (negative attrition). Participants defined success and categorized themselves accordingly. Twenty-five percent of students left because they achieved their goals. Twenty-three percent left because of conflicts with employment. Fifteen percent of students left because of problems that made continued attendance difficult, such as personal, health, financial, and child-care problems.

Fralick reported significant differences ($p < .05$) on *t*-tests between the successful and unsuccessful groups. The unsuccessful student was more likely to have academic, financial, personal, health, or child-care problems. The successful student was more likely to have a definite goal or college major and a high school GPA of B+ or above. Gender and ethnicity were not significantly associated with attrition. Students with personal problems, no goal or college major, and a high school GPA of C or below were at-risk for negative attrition. Where Fralick identified no gender differences in his community college study, Odell and Schumacher (1998) reported significant differences between males and females at a business college.

Gender differences on standardized test of mathematics were the focus of Odell and Schumacher's (1998) study. Their research explored whether reported gender disparities in math attitudes and measures of math ability were present in students planning to major in business. The study participants were freshmen ($N = 336$) entering Bryant College, a 4-year business college in New England. The data were analyzed by course, based on placement test scores, and gender for remedial males ($n = 44$), remedial females ($n = 28$), regular males ($n = 140$), and regular females ($n = 124$).

The predictor variables were all measured on the interval level and included mean high school rank, SAT-Mathematics score, SAT-Verbal score, placement test score, and thirteen survey question scores. The survey instrument, developed by Bryant College faculty, measured responses on a 5-point Likert-type scale except for the final question regarding time per week spent studying math in most recent high school course. The other twelve survey questions centered on participant perceptions and attitudes toward math. The criterion variable was first semester grade point average.

Using Bonferroni's correction to an alpha of .0083 (.05/6), one-tailed t tests revealed significant differences between males and females on two perception variables. The researchers calculated forward and backward stepwise multiple regression equations and selected the best models for each subgroup after considering R-square. The regression model for remedial males produced an adjusted R^2 of .30. The model for remedial females produced an adjusted R^2 of .40. The model for regular males resulted in an adjusted R^2 of .29; regular females' adjusted R^2 was .26. Males and females differed significantly on their attitudes about math and their GPA predictability. Some of these differences were related to course grades.

Summary. The prediction of academic performance for nontraditional students at vocational schools, technical colleges, or community colleges presents a unique challenge to researchers for two reasons. First, the institutions vary widely. Second, student preparation, background, and personal circumstances vary even more. The demographic variables of race and sex predicted academic performance at a technical postsecondary institution (Taube & Taube, 1990). Entering GPA best predicted cumulative GPA at a chiropractic college (Tan, 1991). Conversely, the predictive power of attitudinal data at a four-year business college overshadowed the input of SAT and high school GPA (Odell & Schumacher, 1998). A second group of nontraditional students, college athletes, were the focus of the following studies.

Student Athletes

A 1992 study by Sedlacek and Adams-Gaston considered the validity of noncognitive variables as predictors of college grades for athletes. The researchers based their investigation on the theory that student-athletes more closely resemble nontraditional

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students than traditional students. The participants were the incoming recruited freshman athletes ($N = 105$) at a large eastern Division I university. All freshman athletes completed the Noncognitive Questionnaire (NCQ) during fall orientation. The NCQ (Tracey & Sedlacek, 1984) consisted of 29 items, Likert-type and open-ended, measuring eight factors: (a) Positive Self-concept, (b) Realistic Self-appraisal, (c) Understands and Deals with Racism, (d) Prefers Long-range Goals, (e) Availability of Strong Support Person, (f) Successful Leadership Experience, (g) Community Involvement, and (h) Knowledge Acquired in a Field. Prior reported test-retest reliability ranged from .70 - .94.

The interval-level predictor variables were the eight NCQ factors and SAT-Mathematics (SAT-M) and SAT-Verbal (SAT-V) scores. Correlational analysis revealed SAT-M and SAT-V were not significantly related to athletes' grades. Four NCQ variables (positive self-concept, realistic self-appraisal, strong support person, and community involvement) possessed significant ($p < .05$) zero-order correlations with first semester grades. Sedlacek and Adams-Gaston (1992) performed stepwise multiple regression. The NCQ variables of strong support person, community involvement, and positive self-concept, in that order, entered the equation to yield a multiple R of .43. Compared to traditional students with grades significantly related to aptitude test scores, NCQ scores and grades indicated student-athletes more closely resemble nontraditional students.

A 1992 investigation by Young and Sowa also focused on student athletes. Young and Sowa focused on the predictability of Black student athletes' academic performance. The researchers addressed two issues: (a) the cognitive and noncognitive variables

predictive of the academic success of Black student athletes, and (b) the best combination of cognitive and noncognitive variables for predicting the academic success of Black student athletes. Their sample consisted of all full-time Black student athletes ($N = 136$) admitted as freshmen between fall 1984 and fall 1988 at a medium-sized, predominantly White NCAA Division I university. The sample was 72% men and 28% women, comparable to the three-to-one male to female Black student athlete ratio at the university.

Participants completed Tracey and Sedlacek's (1985) noncognitive questionnaire (NCQ). In addition to the eight interval-level NCQ noncognitive predictor variables (self-concept, self-appraisal, racism, goals, support, leader, community service, and knowledge acquired), Young and Sowa (1992) considered four continuous cognitive predictors (SAT-Verbal score, SAT-Math score, SAT-Total score, and high school decile class rank). The criterion variables were semester GPAs (semester one, two, three, and four), cumulative GPA (year one and two), and credits earned for each semester and cumulatively each year for the first two years of college. The researchers performed correlational and multiple regression analyses.

The results of Young and Sowa's (1992) correlational analyses indicated that three noncognitive variables (self-concept, long-term goals, and knowledge acquired) and one cognitive variable (high school grades) were consistently significantly ($p < .05$) correlated with college grades. High school class rank and knowledge acquired produced the most consistent high correlations with credits earned. Long-term goals, high school grades, and community service were the only variables to enter the multiple stepwise regression analyses as significant ($p < .05$) predictors of the six dependent GPA variables.

Only noncognitive variables (long-term goals, racism, and community service) entered the regression equations for predicting the six dependent earned credit variables. The r values for the twelve regression equation ranged from .25 to .39. These findings supported the inclusion of noncognitive variables, in addition to cognitive predictors, in the grade and credit prediction models for Black student athletes.

Summary. Both student athlete studies used the Noncognitive Questionnaire (NCQ). SAT scores were not significant contributors to the regression equation for either study. NCQ variables consistently entered the regression equation. High school rank and high school grades contributed respectively to the prediction of credits completed and cumulative college GPA. Based upon these findings, researcher should exercise caution when combining student athletes and traditional students in one category for the purpose of GPA or persistence prediction research. One category of nontraditional students covers the spectrum from liberal arts institutions to community colleges, vocational schools to Ivy League universities: at-risk students.

At-risk Students

First year performance by first-generation college students was the focus on Riehl's 1994 study at Indiana State University. In an effort to better understand the specific challenges first-generation college students faced at the university, Riehl compared academic preparation and academic aspiration variables of first-generation students to all other students in the sample. Of the 2,190 entering freshmen in the sample population, 774 indicated neither parent attended college on the Student Information Questionnaire (SIQ). The 115-item SIQ contained questions in five categories: general information, family background, secondary school background, choice of college, and college plans.

Riehl analyzed the following continuous variables using t-tests: (a) SAT-Total score, (b) high school GPA, (c) high school percentile class rank, and (d) first semester college GPA. Riehl used chi-square to analyze the following categorical variables: (a) predicted first semester GPA (five levels), (b) degree intended (eight levels), (c) first semester dropout status, and (d) second-year return status. The first-generation students scored lower on SAT-Total, high school GPA, high school class rank, and first semester college GPA.

Results from the t-tests revealed significant ($p < .05$) differences between the two groups on SAT scores, high school GPA, and first-semester college GPA. Chi-square results, significant at the .01 level, revealed first-generation students dropped out in the first semester more frequently, returned for the second-year less frequently, and reported lower grade predictions and degree intentions. First-generation students, with lower scores on traditional measures of academic preparation and aspiration, were less successful during their first semester in college.

Hood (1992) also focused on at-risk students by designing a study to investigate whether and to what extent noncognitive and traditional precollege variables predicted first semester college grade point average and retention status. At risk freshmen were students educationally underprepared for the challenge of postsecondary academics by the college's standards. Hood anticipated improved attrition prediction and variance explanation with the inclusion of noncognitive variables in the model. The participants were freshmen ($N = 409$) specially admitted to a large, predominantly White, midwestern state university in the Educational Services and Programs (ESP) division. ESP students failed to meet one or more of the following minimum college entrance requirements:

high school GPA, high school courses taken, or ACT scores. The sample was 60% Blacks (20% male, 40% female) and an average 13% each of Whites (6% male, 6% female), Hispanics (5% male, 6% female), and Asians (7% male, 7% female).

Participants completed the 67-item Non-Cognitive Questionnaire-Revised (NCQ-R). The NCQ-R contained nominal items, items measured on a Likert-type scale, and three open-ended questions. Median test-retest reliability was .85 for all items. Two raters, with intercorrelations ranging from .84 to .99, converted the open-ended responses into interval-level variables. Principal components factor analyses, conducted by race on the NCQ-R data to assess construct validity, demonstrated support for the following 13 interval-level factors: (a) Leadership, (b) Academic Organization, (c) Academic Self-concept, (d) Social Integration, (e) Long-range Academic Goals, (f) Realistic Self-appraisal, (g) Faculty Expectations, (h) Racial/Ethnic Homogeneity, (i) Campus Fit, (j) Campus Support, (k) Social Control, (l) Family Support, and (m) Academic Exploration. The traditional predictor variables were ACT-English score, ACT-Math score, ACT-Natural sciences, ACT-Social studies, ACT-Composite), and high school percentile class rank. The two criterion variables were first semester GPA and enrollment status. Enrollment status was nominally classified as either enrolled, left, or dismissed. Hood (1992) used stepwise multiple regression, discriminant analysis, and analysis of variance (ANOVA) to analyze the data.

Descriptive statistics indicated Black men achieved the lowest GPA and completed the fewest course hours. Racial subgroups differed significantly on numerous NCQ-R factor scales. Without considering gender, high school class rank and faculty expectations were the only significant ($p < .05$) predictors of GPA. High school class rank predicted

Blacks' and Asians' college GPA. Faculty expectations was a second significant predictor for Asians. When computed by gender and race, with R-square value in parentheses, significant prediction equations resulted for Black males (.10), Black females (.56), White males (.15), Asian males (.15), and Asian females (.16). The discriminant analysis revealed Blacks to be incorrectly classified more frequently than other racial groups. Asians were correctly classified most frequently. Prediction improved for all races with gender included in the equation. The predictive power of traditional precollege variables was significantly improved with the addition of noncognitive variables to the model.

Again using the NCQ instrument, Ting (1997) sought to predict college success using a combination of psychosocial variables, ACT scores, and high school rank. The psychosocial variables came from Tracey and Sedlacek's (1984) Noncognitive Questionnaire (NCQ). Ting hypothesized that noncognitive psychosocial variables could augment the predictability of cognitive predictors for specially admitted students. The participants were specially admitted White freshmen ($N = 124$) to a midwestern state university; each scored below 20 on the ACT and was ranked in the lower 40% of high school rank. Eighty-four participants were men and 40 were women.

The predictor variables were the following eight factors originally reported by Tracey and Sedlacek (1984): (a) Positive Self-concept, (b) Realistic Self-appraisal, (c) Community Service, (d) Knowledge Acquired in a Field, (e) Successful Leadership Experience, (f) Preference for Long-range Goals, (g) Ability to Understand and Cope with Racism, and (h) Availability of Support Person. The interval-level cognitive predictors were ACT-Verbal score, ACT-Reading score, ACT-Mathematics score, ACT-

Composite score, and high school percentile class rank. The academic performance criterion variables were first semester college GPA and second semester college GPA. The persistence criterion variable was freshman credits earned. The researcher performed three forced-entry multiple regression analyses, entering cognitive variables first.

Regression results indicated significant prediction equations for the three criterion variables. ACT-Verbal, high school class rank, and preference for long range goals best predicted first semester GPA yielding a final R-square of .21. The second semester GPA prediction model (R-square = .17) and the retention prediction model (R-square = .14) contained the variables ACT-Composite, high school class rank, and demonstrated community service. Ting's (1997) findings suggested that a combination of cognitive and psychosocial factors better predict academic success and persistence for specially admitted White students than do cognitive predictors alone.

Dalton (1974) also focused his investigation on a population of specially admitted students. Dalton studied the predictive validity of high school class rank and SAT scores on freshman GPA for disadvantaged students. His sample population, 201 freshmen admitted to Indiana University under a special program with waived admission requirements, presented a unique opportunity for research on a minority population of students with widely variant high school class rank and SAT scores. The sample population included Blacks (n = 169), Hispanics (n = 17), and Whites (n = 15) from disadvantaged environments.

The two interval predictor variables were high school percentile rank (HSR) and SAT-Total score. The criterion was college freshman GPA. The sample was split into four

equal groups for statistical analyses: (a) overachievers (low SAT, high HSR); (b) high

ability (high SAT, high HSR); (c) low ability (low SAT, low HSR); and (d)

underachievers (high SAT, low HSR). Dalton computed Pearson correlations (r) and

multiple correlations (R) for each subgroup.

The zero-order correlation between HSR and GPA was .20, significant at the .05 level.

The correlation between SAT-Total and GPA was nonsignificant. The combination of

HSR and SAT best predicted GPA for the underachieving ($R = .62$) and overachieving ($R

= .35$) groups. SAT added little to GPA prediction for the other two groups. Dalton

(1974) compared these results to findings reported by Thomas and Stanley (1969).

Though HSR is a weaker predictor for minority, disadvantaged students than for Whites,

it was superior to SAT scores for this population of students. The addition of SAT scores

to the prediction equation was useful for select subgroups within this sample.

A 1983 study by Hogrebe, Ervin, Dwinell, and Newman explored the effects of two

moderator variables, sex and race, on the relationship between college academic

performance and three predictor variables for developmental studies (at-risk) students.

Because this subgroup of students was below university entrance requirements on high

school GPA, SAT-Verbal, and SAT-Math scores, the study focused on examining the

predictive validity of these three variables on college GPA. The participants were

students ($N = 345$) enrolled in the developmental studies program at a large southern

university between the fall of 1977 and the spring of 1979. The sample contained 183

males, 162 females, 264 Whites, and 81 Blacks.

The interval-level predictor variables used by Hogrebe et al. (1983) were SAT-Verbal

score, SAT-Math score, and high school GPA. The nominal-level moderating predictor

variables were sex (male, female) and race (Black, White). The criterion was college GPA after 45 credit hours. The researchers used multiple regression and then tested for slope and intercept differences between the moderating variable levels. High school GPA was the predictor variable most highly correlated ($r = .28$) with college GPA.

The results of the regression equation comparisons revealed three significant differences. First, the sex intercepts differed significantly ($p < .0001$). The sex slope difference was not significant. Second, the slope difference between the Black and White regression lines was significantly ($p < .01$) different. Finally, the intercept difference when comparing White males and females was significantly different at the .0001 level. The White regression equation included three significant contributors (sex, high school GPA, and SAT-Verbal) and accounted for 19% of the variance in the criterion. The Black regression equation, with SAT-Verbal, SAT-Math, and high school GPA as its significant predictors, accounted for 29% of the variance in the criterion. Hogrebe, Ervin, Dwinell, and Newman's (1983) results supported the use of moderator variables in the prediction of academic performance for developmental studies students. Sex and race moderated the predictive validity of academic predictors on college GPA.

An investigation by Hogrebe, Dwinell, and Ervin (1985) built upon these finding with a continued focus on developmental students. Hogrebe et al. examined college student perceptions of their preparation for college work, student attitudes toward the developmental studies program and the university, and student knowledge of the developmental studies program as predictors of college academic performance. High school GPA and SAT score provided a standard of comparison. Participants were students ($N = 192$) denied regular admission to a large southern university for not

meeting minimum entrance requirements but enrolled in the university's developmental studies program. The sample contained 90 males and 102 females.

The predictor variables were interval-level measures. The researchers recorded nine attitudinal perception variables from a mail questionnaire developmental studies students completed before classes started in the fall. Responses were on a 5-point Likert-type scale (1 = *not at all*, 5 = *very much*) tailored to fit each item stem. The nine variables were number of quarters to exit, preparation for English, preparation for math, preparation for reading, feelings about developmental studies, benefits of developmental studies, importance to parents of your attendance at this institution, importance to you of your attendance at this institution, and prior knowledge of the developmental studies program. High school GPA, SAT-Verbal score, and SAT-Mathematics score were additional predictor variables. First quarter college GPA was the criterion measure.

Hogrebe, Dwinell, and Ervin (1985) used hierarchical multiple regression analyses to analyze the data separately for males and females. The attitudinal variables were grouped into four sets for entry into the regression model based on a priori estimates of variance accountability from highest to lowest. The first set encompassed student perceptions of preparation for college. The second set focused on attitudes about developmental studies. The third set included student attitudes about the university. The fourth set reflected student knowledge of developmental studies prior to enrollment. A separate multiple regression analyzed the association between the academic predictors and the criterion.

The only statistically significant ($p < .05$) result for the male and female attitudinal regression models was Set 1 variables for males. Set 1 accounted for 18% of the variance in first quarter GPA. The only statistically significant ($p < .05$) result for the academic

regression models was for males. SAT scores and high school GPA accounted for 33% of the variance in first quarter GPA. When corrected for restriction in range, the female regression models reflected similar results as the males (21% and 31%, respectively). Follow-on analyses using both attitudinal and academic predictors together revealed no significant contribution by student perception variables above that accounted for by the traditional academic predictors of SAT and high school GPA. Another type of at-risk student, in addition to those admitted into developmental studies, is the student readmitted to the institution following academic dismissal.

Santa Rita (1998) reported findings from his experiment testing the predictive usefulness of 50 variables on academic performance for readmitted students. The purpose of Santa Rita's study was to add to the current knowledge regarding the academic performance and success of students readmitted to a community college following dismissal for academic failure. Participants were readmitted students ($N = 86$) at Bronx Community College (BCC). Fifty-five females and 31 males participated.

The 50 predictors variables came from four categories. Ten interval-level test score variables resulted from the City University of New York (CUNY) placement test, the Maudsley Personality Inventory, and the Survey of Study Habits and Attitudes. Eight educational history items, each at the interval level with the exception of ordinal high school rank included: (a) semesters completed at this college, (b) total semesters completed, (c) total credit hours completed, (d) overall BCC grade point average (GPA), (e) overall college GPA, (f) GPA first BCC term, (g) GPA last BCC term attended, and (h) high school percentile rank. Twenty biographical variables were created from the following: (a) sex; (b) marital status; (c) high school type; (d) high school curriculum;

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(e) educational aspiration; (f) how time was used between academic failure and readmittance; (g) liked work while absent from college; (h) health; (i) effect of health; (j) months since last in college; (k) curricula; (l) reaction to college; (m) ability to finance college education; (n) birth order; (o) expectation of success; and (p) parental expectations.

Twelve categorical opinion variables resulted from the participant responses (very important, important, minor importance, and not important) to the following twelve questions: (a) could not get desired program of study, (b) dissatisfied with instructors or teaching methods, (c) dissatisfied with academic advisement, (d) unhappy with major, (e) dissatisfied with this college, (f) too many personal problems, (g) personal health problems, (h) illness in family or other family health problems, (i) no clearly defined goals, (j) too many extra-curricular activities, (k) irregular class attendance, and (l) did not study enough.

The nominal dependent variable was membership in either the "Pass" group (GPA $\geq$ 2.0) or "Fail" group (GPA $<$ 2.0) based on end-of-semester GPA. Santa Rita (1998) used frequency-within-categories and chi-square tests of independence, plus Yates' correction for continuity when expected cell frequency was less than five, for nominal variables. For interval data, Santa Rita used two-tailed t tests to determine statistical significance between means and point-biserial correlations. The researcher also partitioned the sample by sex and computed tests of significance on each variable by sex.

There was no significant difference between the proportion of successful "Pass" males and females. Successful males scored significantly higher than unsuccessful males on mathematics, delay avoidance, educational acceptance, and study orientation; successful

males scored significantly lower on extraversion. "Pass" females scored significantly higher than "Fail" females on mathematics and work methods. Four biographical factors significantly differentiated between successful and unsuccessful students. Married males and females were more successful than their single counterparts. All students who loafed since last in college failed. Females with no financial concerns performed more poorly than those with concerns. Birth order predicted academic success in the entire sample, but not by specific gender.

Santa Rita (1998) combined the significant biographical predictors of marital status, financial concerns, and time spent since last attended college into an overall incentive factor. Santa Rita's results indicated incentive and specific academic skills were the significant predictors of academic success for students readmitted following an academic dismissal. Past academic record did not differentiate between groups.

Hall and Gahn (1994) also examined the predictors of academic success for readmitted students. Hall and Gahn's research focused on the relationship between six predictors and academic success for students previously dismissed for academic reasons. The goal of the study was to confirm or refute the assumptions employed by the University of Kansas College of Liberal Arts and Sciences in readmittance decisions. The study participants ($N = 160$) were entering freshmen in 1987, dismissed for academic problems during one of their first three years, but subsequently readmitted.

Hall and Gahn (1994) used logistic regression to predict the odds of a readmitted student succeeding academically (graduated, continued enrollment, or left in good standing). The six predictor variables were split between indicators of past performance (cumulative GPA at time of dismissal, school level at time of dismissal, and ACT-

Composite score) and experiences following dismissal (GPA elsewhere, number of semesters between enrollments, and number of hours earned elsewhere). The dichotomous dependent variable was academic success (yes, no).

The logistic regression analysis, using hierarchical entry and listwise deletion for missing data, produced a model with cumulative GPA at time of dismissal and transfer GPA as the only two significant ($p < .05$) predictors of academic success. A high correlation between school level (freshman, sophomore, and junior) and dismissal GPA ($r = .68$) indicated another source of potential predictive value. Hall and Gahn's (1994) findings provided university officials additional information for decisions regarding the prediction of academic success for readmitted students.

Universities frequently mandate or offer special programs to assist "at-risk" students. Anneliese Bruner (2001) detailed the importance of program evaluation in college access and preparation programs at urban universities. College prep programs for urban teens are designed to improve access to postsecondary education. Measures of program success varied by program and institution. Bruner's focus was on research conducted by the University of Southern California's Center for Higher Education Policy Analysis (CHEPA). William Tierney, CHEPA Director, and Linda Hagedorn, CHEPA Associate Director, authored *Increasing Access to College: Extending Possibilities for all Students* (2002). This book addressed access program types and evaluation guidelines for standardizing measures of success.

A good evaluation model, as endorsed by CHEPA, answers three questions: (a) who does the program serve?, (b) what are the indications of programmatic success?, and (c) what are the indicators of organizational effectiveness? A program's framework should

encompass five components: (a) technology to capture and maintain accurate records, (b) a longitudinal comparative database across organizations, (c) multiple measures of effectiveness, (d) analysis of one discrete evaluation component each year, and (e) ongoing schema for evaluating costs and communicating effectiveness. CHEPA suggested all access programs contain an academic component in addition to whatever other services (economic, social, cultural, etc.) they provide. Urban universities face unique missions and demands. Effective evaluation of access and prep programs is critical to success.

Summary. At-risk students, themselves a subgroup of nontraditional students, were broken down even farther by the preceding studies into smaller groups by race and sex. Race and sex were significant moderators of predictor significance (Hood, 1992; Hogrebe, Ervin, Dwinell, & Newman, 1983). The predictive validity of cognitive variables, when compared to traditional students, is unique for each at-risk subgroup (e.g., first-generation students, readmitted students, underachievers). Nonintellective variables, such as marital status, noncognitive measures, and birth order, made significant improvements to the accuracy of the prediction equations for this population of students.

Institutions face a challenge when predicting the academic performance of nontraditional students (Riehl, 1994). As with their traditional counterparts, conventional academic measures (e.g. high school GPA, high school rank, and aptitude test scores) consistently account for the greatest amount of variance in nontraditional students' college academic performance and persistence (Dalton, 1974; Young & Sowa, 1992). Noncognitive variables, such as goal commitment, self-concept, and support network (Sedlacek & Adams-Gaston, 1992; Hood, 1992), are key components to success for

students admitted below the minimum requirements or otherwise at-risk. Environmental and personal variables frequently contributed to the prediction equations (Santa Rita, 1998). Race and gender were significant moderating variables (Hood, 1992; Hogrebe, Ervin, Dwinell, & Newman, 1983; Odell & Schumacher, 1998).

Prediction by Race

A significant body of research exists on the prediction of college academic performance by race. One stream of research focuses on this concern by testing the racial validity and fairness of traditional predictor measures, such as the SAT, ACT, and high school GPA (Stanley & Porter, 1967; Cleary, 1968; Nettles, Thoeny, & Gosman, 1986). Additionally, researchers seek to unearth and explore nonintellective predictors (e.g., demographic, attitudinal, and environmental variables) capable of accounting for some of the variance in college success associated with ethnicity (Tracey & Sedlacek, 1985; Eimers, 2001). Both research paths can provide college officials with information and decision-making criteria needed to foster an environment supportive to all students (Hawkins, 1989). Whereas this body of research initially focused on the racial differences between Blacks and Whites (Munday, 1965), research on the prediction of college success, persistence, and graduation currently encompasses numerous racial groups and ethnic backgrounds (Perry, 1981; Ott, 1988; House, 1996; Strage, 2000).

Hawkins (1989) emphasized the importance of understanding the variables affecting minority academic achievement and retention in college. Aggressive marketing and recruitment of minority students is a waste of institutional resources if the academic and social environments on campus do not support minority success. Hawkins (1989) suggested universities evaluate the following areas for effectiveness in supporting

minority students: (a) financial aid policies, (b) counseling services, (c) academic advising and support services, and (d) minority affairs office functions. If the goal of increasing minority enrollment is to increase minority graduations, the university must work to understand the variables impacting attrition and move to maximize the likelihood of minority success. This section is subdivided into the following parts: (a) Blacks compared to Blacks, (b) Blacks compared to Whites, and (c) multiple racial comparisons.

Blacks Compared to Blacks

Munday (1965) researched the predictive validity of ACT scores for Blacks attending predominantly Black colleges in southern states. Munday studied five southern Black colleges that participated in the ACT Research Service. The respective sample sizes were 105, 205, 233, 561, and 554. Three schools were four-year colleges. Two schools offered advanced degrees.

Munday (1965) used two sets of predictors. The T set of predictors was ACT-English, ACT-Mathematics, ACT-Social Studies, and ACT-Natural Science scores. The H set of predictors was high school grade averages in the following areas: English, mathematics, social studies, and natural science. The criterion variables were college GPA in the same areas plus overall grade point average. Munday computed three multiple correlations per school per criterion variable. The T predictors, ACT scores, generated the first multiple *R*. The H predictors, high school averages, generated the second multiple *R*. The TH multiple *R* was an average of the first two values.

The T multiple correlations, highest when predicting college English grades, were comparable to national averages. The H multiple correlations, computed using high school grades, were lower than the national average for all schools on each criterion

variable. Compared to all ACT Research Service schools, these five schools were percentile ranked between 31 to 73 in predictability of grades. Munday's (1965) findings indicated Black students' grades at predominantly Black institutions were as predictable as other students' grades at the schools participating in the ACT Research Service using ACT scores. High school grades were less effective predictors.

McKelpin (1965) reported results from an investigation studying the predictive validity of scholastic aptitude scores and high school average on college freshman performance at a Black liberal arts college. McKelpin's focus was determining whether these predictors were as valid for Black students at a Black college as had been reported for White students at White colleges. The participants were randomly selected freshmen ($N = 830$) from three entering classes (1961-1963) at the North Carolina College at Durham.

The predictor variables were SAT-Verbal score, SAT-Math score, and high school average. The criterion was first semester college GPA. McKelpin computed descriptive statistics, correlations and multiple correlations by gender and year. Females earned higher college and high school GPAs than males for each year group. SAT score means and standard deviations indicated a restriction of range.

McKelpin's (1965) multiple correlations were similar to the values reported in the literature for White students at White colleges. The multiple correlation between the three predictors and GPA for males ranged between .60 and .66 for the three year groups. The multiple correlation between the three predictors and GPA for females ranged between .64 and .67 for the three year groups. SAT scores and high school average

accounted for 36% to 45% of the variance in first semester college GPA for Black students at a Black liberal arts college.

A study by Tatham and Tatham (1974) followed this line of research by testing three hypotheses related to Black students' academic success at a private liberal arts college. The three null hypotheses were: (a) males and females would not differ significantly on pre-admission measures of academic achievement, (b) academically successful and unsuccessful students would not differ significantly on pre-admission measures of academic achievement, and (c) there would be no interaction between sex and college performance with respect to pre-admission measures of academic achievement. The sample ($N = 73$) consisted of 28 females and 45 males enrolled for at least one semester at a private liberal arts college between 1964 and 1970.

Students were classified as successful if they graduated or maintained a 1.0 GPA. The two nominal independent variables were academic success (yes, no) and sex (male, female). The continuous dependent variables were SAT-Verbal score, SAT-Math score, and high school percentile rank. Tatham and Tatham (1974) performed a two-way multivariate analysis of variance (MANOVA) for the entire sample and one for each sex.

The MANOVA results indicated a significant ($p < .005$) difference between males and females on measures of pre-admission measures of academic achievement, leading to a rejection of the first null hypothesis. The null hypotheses addressing academic success differentiation and the interaction sex x academic success could not be rejected. Tatham & Tatham's findings indicated a weak relationship ($p < .10$) between pre-admission measures of academic achievement and academic success for Blacks in college,

highlighting the need for admissions counselors to consider additional variables when making admissions decisions regarding Black applicants.

Stanley and Porter (1967) compared the correlation of SAT scores to freshman grades for Blacks at predominantly Black colleges and Whites at predominantly White college. Prior research suggested differential predictive validity of aptitude tests for minorities. This study compared the predictive validity of aptitude tests in racially homogenous environments. The research data encompassed six academic years from the fall of 1959 through the spring of 1965. Within the University of Georgia system, Stanley and Porter compared Blacks at three predominantly Black colleges to White males at 15 predominantly White institutions and White females at 14 predominantly White institutions.

The independent nominal-level variables were: (a) racial composition (Black/non-Black), (b) colleges nested within race, and (c) year. The first four interval dependent variables were: (a) SAT-Verbal means, (b) SAT-Math means, (c) SAT-Verbal standard deviations, and (d) SAT-Math standard deviations. The last four interval dependent variables were correlations between college GPA and the following: (a) SAT-Verbal score, (b) SAT-Math score, (c) SAT-Verbal and SAT-Math, and (d) SAT-Verbal, SAT-Math, and high school grades.

Stanley and Porter (1967) reported Whites scored uniformly higher than Blacks on SAT tests for the six years. Three-way (race x college x year) analysis of variance (ANOVA), conducted separately for males and females using the correlation between SAT-Verbal scores and freshman grades as the dependent variable, revealed White females' grades were significantly ($p < .01$) better predicted than for Black females. No

significant differences existed between males. Multiple correlation coefficients using SAT-Verbal, SAT-Math, and high school grades indicated White females' grades were the best predicted of the four groups. White males' grades were the least predictable. Despite restriction in range limitations, based upon Blacks' lower test scores, SAT scores and high school grades predicted GPA reasonably well at predominantly Black institutions.

Thomas and Stanley (1969) reviewed the value of high school grades, compared to standardized test scores, for predicting the college grades of Black students using data from previous studies and from a predominantly Black university. The purpose of their inquiry was to further illuminate the variability of predictor efficacy along ethnic divisions.

Based upon the studies considered, Thomas and Stanley (1969) concluded that high school scholarship (i.e., grade point average or rank in class) was the single best predictor of college success. Other predictors were scholastic aptitude and achievement tests. Generally, women were more predictable than men. High school scholarship correlated most highly with first year college GPA, as opposed to some other measure of the college record.

Studies by Munday (1965), Cleary (1968), Peterson (1968), and Funches (1967) concurred. Black males' high school records, relative to Whites and Black female students, poorly predict college success. SAT and ACT scores were more consistently and highly correlated to Black males' college grade point average than any measure of high school performance. Thomas and Stanley (1969) advanced four possible explanations for this disparity: (a) invalidity of grades in high school and/or college,

particularly for Black males; (b) unreliability of grades and grade reporting in Black high schools; (c) intergroup differences in personality characteristics; and (d) restriction in range due to selection processes. The best forecasts resulted when aptitude scores and high school grades were combined to predict college grades.

Thomas (1979) assessed the relative effectiveness of high school rank, compared to standardized test scores, for predicting college grades of Black students as a function of academic level and sex. The participants were freshmen in the 1969 entering class of a predominantly Black liberal arts college in the East. The sample was evenly split between males and females. The college places incoming freshmen into one of three curricula based on results of aptitude and standardized achievement test administered before classes begin. Forty-four males and 44 females were from Curriculum A, studies for students with the most serious deficiencies. Forty-eight males and 48 females were from Curriculum B, studies for students in the 'regular' program. Forty-eight males and 48 females were from Curriculum C, studies for students in the top 10% of the class.

The predictor variables were the ACT-English score, the ACT-Math score, normalized high school rank, and sex. The criterion variable was first semester college grade point average. With the exception of ACT-Math for Curriculum B, female averages were higher than males on the four variables in all three Curricula. Thomas initiated four two-way ANOVAs with sex and curriculum as independent variables and either ACT-Math, ACT-English, high school rank, or college GPA as the dependent variable. The high school rank ANOVA yielded a significant main effect for sex; females earned higher high school ranks than males. The ACT-English ANOVA yielded significant main effects for sex and curriculum. Females' ACT-English scores were higher than males.

Curriculum C students scored higher than B; Curriculum B students scored higher than A. The ACT-Math ANOVA yielded a significant main effect for curriculum level. The college GPA ANOVA yielded significant main effects for sex and curriculum, similar in interpretation to ACT-English.

Thomas (1979) performed six stepwise regression analyses, one per sex per curriculum level, with high school rank, ACT-English scores, and ACT-Math scores as predictor variables. The dependent variable was college GPA. For females, across all curricula, high school rank was the greatest contributor to R. For males, ACT-Math was the biggest contributor to R in Curriculum A, ACT-English was the biggest contributor in Curriculum B, and high school rank was the biggest contributor to R in Curriculum C.

Zero-order correlation coefficient analyses indicated that the multiple Rs based on the two aptitude test scores surpassed the R generated solely from high school rank for all gender and ability groupings except Curriculum A females and Curriculum C males. The Gulliksen-Wilks analysis of covariance revealed significant differences in the intercepts of the regression lines and planes for males versus females for Curricula B and C. For Curriculum A, there was no statistical difference between the male and female regression equations based on test scores or test scores and high school rank. The ANACOV results supported the earlier findings of less predictive power of high school rank for Black males than Black females. Thomas' focus on academic predictors is contrasted to Pfeiffer and Sedlacek's concentration on non-academic variables.

A study by Pfeiffer and Sedlacek (1974) explored the potential of non-academic variables as predictors of college grades for Black students. The researcher's primary intent was identifying better correlates for predicting Black students' academic success.

The participants were Black freshmen entering the University of Maryland (UM) in the fall of 1968.

Three personality questionnaires, administered on different days of summer orientation, yielded unique sample sizes for each instrument. The California Psychological Inventory (CPI, $n = 79$) included 19 scales. The factors were dominance, capacity for status, sociability, social presence, self acceptance, sense of well-being, responsibility, socialization, self-control, tolerance, good impression, communality, achievement via conformance, achievement via independence, intellectual efficiency, psychological mindedness, flexibility, femininity, and Leventhal's anxiety scale. The Holland Vocational Preference Inventory (HVPI, $n = 66$) contained 19 scales. The factors were realistic, intellectual, social, conventional, enterprising, artistic, self-control, masculinity, status, infrequency, and acquiescence. The University Student Census (USC, $n = 107$) contained 46 items. Twenty-nine USC items produced categorical responses. Seventeen USC items asked for interval-level responses on a Likert-type agreement scale.

Pfeiffer and Sedlacek's (1974) research design was correlational analysis at the .05 level. Three HVPI scales (social, frequency, and masculinity) were significantly correlated to college GPA. Significant correlations existed between college GPA and the following CPI scales: (a) sense of well-being, (b) responsibility, (c) socialization, (d) communality, (e) achievement via conformance, (f) achievement via independence, and (g) intellectual efficiency. Two of the categorical USC items were significantly related to college GPA.

Based on past research involving UM White students, several racial differences surfaced. Three items from the USC (being excited about coursework, feeling instructors care, and feeling that the University should use its influence to improve social conditions) were significantly correlated to college GPA for Blacks but not Whites. The HVPI's infrequency scale, measuring preference for unpopular, feminine, low-status jobs, correlated significantly positive ($r = .31$) for Blacks but significantly negative ($r = -.16$) for Whites. Several non-intellectual variables correlated to college GPA for Black students greater than for Whites.

Trippi and Stewart (1989) assessed the relationship between noncognitive academic self-appraisal variables to persistence and grades for Black students. Their study controlled for the traditional academic success predictors of aptitude and achievement measures. Building upon the research of Tracey and Sedlacek (1984, 1985, and 1987), Trippi and Stewart sought to clarify the beliefs, expectations, and experiences supporting realistic self-appraisal's validity as a predictor of Black academic success. The participants were Black freshmen ($N = 415$) entering a large northeastern university in 1985 and 1986.

All predictor variables were measured at the interval level. Aptitude predictor variables were the SAT scores for verbal and mathematics subtests. The achievement predictor was average grade for all courses taken between ninth and eleventh grades in high school. Self-appraisal predictors were eight measures from the Educational Planning Survey (EPS), an instrument developed by the institution. Participants recorded their response for one factor, expected grade performance, using a 7-point Likert-type scale (7 being more favorable than 1). A second factor was expected study hours per

week. Six factors, recorded using a 5-point Likert-type scale (1 being more favorable than 5), were: (a) concern about note-taking skills, (b) concern about organizational skills, (c) concern about preparing for tests, (d) concern about reading comprehension, (e) concern about reading speed, and (f) concern about understanding lectures. A binary variable, major field, accounted for potential differences in course difficulty between science and non-science majors. The study considered four criterion variables: (a) freshman grade point average, (b) science course grade average, (c) non-science course grade average, and (d) enrollment status after one year (persistence).

Trippi and Stewart (1989) used least squares regression to assess college grade performance and logistic regression to assess persistence. With all independent variables in the model, the prediction equation for freshman GPA was significant at the .0001 level. Statistically significant predictors were high school grades ($p < .0001$), SAT-Verbal ($p < .001$), and major field ($p < .05$). Non-science majors earned higher grades. The regression analysis for science grades revealed high school GPA, SAT-Verbal, and three noncognitive factors (concerns about preparing for tests, reading comprehension, and reading speed) were significant ($p < .05$) predictors. The non-science grade regression analysis indicated high school GPA and SAT-Verbal were significant ($p < .001$) predictors.

The logistic regression analysis for persistence with all independent variables in the model was significant at the .0001 level. High school GPA ($p < .05$) and freshman college GPA ($p < .0001$) were significant predictors. A significant positive relationship ($p < .05$) existed between two noncognitive variables, concern about ability to understand lectures and grade performance expectations, and persistence. Trippi and Stewart's

(1989) findings supported the usefulness of noncognitive variables as predictive measures of Black undergraduate academic success and persistence.

Summary. The development of prediction equations for Black student using Black student information highlighted more similarities than differences to the prediction of academic achievement and persistence for all students. The SAT predicted academic achievement near the national average at predominantly Black colleges (Munday, 1965). College GPAs for Black females were consistently better predicted than for Black males (McKelpin, 1965; Tatham & Tatham, 1974). High school performance was a stronger predictor for both sexes than aptitude measures (Thomas & Stanley, 1969). Without the confounding influence of race, the prediction of Black student college performance and persistence at Black institutions compared favorably with the prediction of White student academic performance and persistence at predominantly White universities.

Blacks Compared to Whites

Cleary (1968) studied test bias in the SAT. Based upon prior research, Cleary postulated that the SAT's predictive power of Black students' grades at Black colleges approximated that of White students' grades at White colleges. This investigation addressed an unresolved issue, the predictive validity of the SAT for Blacks and Whites at integrated colleges. The participants ($N = 3,399$) were Black ($n = 273$) and White ($n = 3,126$) students enrolled in three public universities.

The predictor variables were the SAT-Verbal and SAT-Math scores for all students, and high school percentile rank-in-class or high school grade average, depending on availability of data in the college record. School 1 provided SAT scores. School 2 provided SAT scores and high school rank. School 3 provided SAT scores, high school

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rank for 50% of students, and high school average for 60% of students. Cleary

performed correlational analysis and multiple regressions on the data for each racial

subsample, than computed a regression test of the analysis of covariance to test two

hypotheses: equality of regression slopes, and given that the slopes are equal, equality of

intercepts. Equal slopes and unequal intercepts can be interpreted as bias.

Cleary (1968) found no difference in regression slopes between Black and White

students. The test for equal intercepts at Schools 1 and 2 indicated no difference. The

intercepts for School 3's equations, comparing Black students, a matched sample of

White students, and a random sample of White students revealed significant ($p < .01$)

differences. Black students' GPAs were underestimated using three sets of predictors:

(a) SAT scores, (b) SAT scores and high school rank, and (c) SAT scores and high

school average. Two of the three schools provided no evidence for positive bias for

Black students' academic performance. Positive bias was present for the third school and

increased with the addition of high school performance measures.

Sampel and Seymour (1971) compared Black and White students' academic

performance in college and the predictive validity of two college entrance measures

relative to each race. The researchers compared the performance of Blacks and Whites

on each variable and the relationship between the predictors and college GPA. The study

sample ($N = 360$) consisted of 180 Black undergraduate students at the University of

Missouri-Columbia (UMC) during the academic year 1968-1969 and a group of 180

White students matched by sex, college division, and class year at the same institution.

The subsample was further partitioned by sex and class year (freshmen, upperclassmen).

The two interval-level predictor variables Sampel and Seymour (1971) used were the Cooperative School and College Ability Test (SCAT) total score and a measure of high school rank comparative to other entering freshmen at UMC the same year. The criterion variable was cumulative college grade point average. Data analysis included t-tests for group mean differences and correlations.

The research design produced seven t-tests for each variable by comparing Black and White student scores in each of the following categories: (a) male freshmen, (b) male upperclassmen, (c) female freshmen, (d) female upperclassmen, (e) total freshmen, (f) total upperclassmen, (g) total sample. For SCAT and cumulative college GPA, Whites scored significantly ($p < .05$) higher in every comparison. For high school rank, White female upperclassmen were significantly ($p < .05$) higher than Black female upperclassmen. Partially as a result of this difference, all White upperclassmen scored significantly ($p < .05$) higher than all Black upperclassmen.

The seven correlations for Blacks and Whites between each predictor and cumulative GPA revealed significant ($p < .05$) relationship in all areas with one exception. SCAT and high school rank were not significant predictors of Black males' academic performance at either the freshmen or upperclassmen levels. Sampel and Seymour's (1971) findings indicated significant ($p < .05$) differences between Blacks and Whites on SCAT scores and college GPA, less difference when considering high school rank, and no significant power for either SCAT or high school rank in predicting college GPA for Black males.

Nettles, Thoeny, and Gosman (1986) sought alternative sources of predictive power by comparing Black and White students' college experiences and performance. Nettles

et al. addressed issues of racial equality in their study, centering their research on identifying differences in Black and White students' college performance, predictors of that performance, and the effect of college experiences on performance. The sample, stratified by race (Black, White) and predominant institutional type (large White public, regional White public, Black public, large White private, Black private) consisted of students ($n = 4,094$) and faculty ($n = 706$) from 30 colleges in ten southern and eastern states. Student participants completed the Student Opinion Survey (SOS). Faculty participants completed the Faculty Opinion Survey (FOS).

Of 30 independent variables used by Nettles, Thoeny, and Gosman (1986), the following seven predictors were the result of factor analysis on SOS items: (a) academic integration, (b) personal feelings, (c) satisfaction, (d) peer relations, (e) problems, (f) study habits, and (g) socioeconomic status. Sixteen additional student variables were SAT-Total score, race, sex, age, high school GPA, marital status, high school type, work status, work hours, housing, minority status on campus, transfer status, miles from home, degree expectations, and fits between high school and neighborhood to college. Five faculty variables, results of a factor analysis on FOS items, were: (a) satisfaction with institution, (b) teaching style, (c) influence on student development, (d) feeling of racial discrimination, and (e) contact with students. The final two predictors were predominant race at the institution and total enrollment. The dependent variable was self-reported cumulative college GPA.

Nettles et al. (1986) compared Black and White students on categorical variables using chi-square analyses. The researchers used F-tests and multivariate analyses of variance to compare groups mean on related variables, and computed multiple regression

equations to account for variance in college GPA. The strongest bivariate correlation with the criterion was held by high school GPA ($r = .410$). Fifteen variables significantly ($p < .01$) contributed to the prediction of college GPA. Students with high college GPAs were associated with few feelings of racial discrimination, few interfering problems, and high SAT scores and high school GPAs. Four interaction terms, race by SAT scores, satisfaction, peer relations, and interfering problems, were significant ($p < .05$) contributors in a follow-on regression.

Four major conclusions were supported by the results of Nettles, Thoeny, and Gosman's (1986) study. First, a variety of academic, demographic, and attitudinal variables were significant predictors of Black and White students' college performance. Second, SAT scores, student satisfaction, peer relations, and interfering problems held differential predictive validity for Blacks and Whites. Next, several predictors (e.g., high school type, minority status in college, housing, academic integration) accounted for significant racial differences in college performance. Finally, faculty variables accounted for little variance in college GPA for Black and White students. Another option for comparing Black and White student is to evaluate graduation rates by race.

Research by Sanford (1982) addressed the predictability of graduation for Black and White students at a major research university. Participants were Black and White freshmen entering the University of North Carolina at Chapel Hill in the fall of 1974. Sanford's intention was to develop predicted graduation equations for admissions officers' use.

The interval-level predictor variables Sanford (1982) used were: (a) sex (1 = male, 2 = female), (b) race (1 = Black, 2 = White), (c) residency status (1 = in-state, 2 = out-of-

state), (d) major (1 = decided, 2 = undecided), (e) SAT-Verbal score, (f) SAT-Math score, (g) SAT-Total score, (h) predicted GPA (PGA; computed from high school rank in class and SAT scores), (i) high school graduation class size, and (j) high school percentile rank. The criterion variable was graduation status (1 = no, 2 = yes).

Sanford's first multiple regression calculation, using sex, race, PGA, SAT-Math, SAT-Verbal, SAT-Total, and high school rank, yielded an R^2 of .098 for Blacks and .022 for Whites. SAT-Total was the only predictor not significantly contributing to the equations. High school rank was the strongest contributor for both races. Sanford's second multiple regression calculation, including all predictors, produced an R^2 of .144 for Blacks and .049 for Whites. Residency status was the strongest predictor for Whites and the second strongest predictor for Blacks.

The discriminant analysis performed by Sanford (1982), with all predictors entered in the equation, correctly classified 56.65% of Whites and 64.78 % of Blacks. When combined into one group, the discriminant analysis correctly classified 65 of freshmen correctly as graduates or non-graduates. Seventy-six percent of the sample graduated; therefore, the classification results were not an improvement over chance. The results of this investigation highlighted differences in predictive utility for academic variables on freshman GPA between Blacks and Whites. In an effort to improve upon the prediction of Black and White students' academic performance, persistence, and graduation, Tracey and Sedlacek explored the predictive potential of noncognitive variables.

Tracey and Sedlacek's 1984 investigation addressed a reported decreasing retention rate among minority students at predominantly White institutions. The research design tested the Noncognitive Questionnaire's (NCQ) reliability, construct validity, and

predictive validity for White and Black students' academic success and retention beyond the SAT's contribution. The participants were incoming freshmen ($N = 1,973$) at a large eastern university in 1979 ($n = 1,529$; 1,339 Whites and 190 Blacks) and 1980 ($n = 444$; 355 Whites and 89 Blacks).

The 23-item NCQ contained two nominal items, 18 items measured on a Likert-type scale, and three open-ended questions. Median test-retest reliability was .85 for all items. Two raters, with intercorrelations ranging from .83 to 1.00, converted the open-ended responses into interval-level variables. Principal components factor analyses, conducted by race on the NCQ data to assess construct validity, demonstrated support for the following six factors originally reported by Sedlacek and Brooks (1976): (a) Leadership, (b) Recognizing Racism, (c) Preference for Long-range Goals, (d) Realistic Self-appraisal, (e) Support for College Plans, and (f) Self-confidence. The predictor variables for the stepwise multiple regression analyses were the individual NCQ items and SAT score. Eight analyses included regression on first semester GPA for Whites and Blacks for 1979 and 1980, regression on third semester cumulative GPA for Whites and Blacks from 1979, and two third semester enrollment status discriminant analyses for Whites and Blacks from 1979.

Tracey and Sedlacek's (1984) results indicated NCQ variables consistently accounted for significant ($p < .05$) additional variance beyond SAT scores' predictive power. White students' GPAs were better predicted by SAT alone, NCQ alone, and SAT combined with the NCQ. Combined model multiple R's for White students ranged from .51 to .59. Combined model multiple R's for Black students ranged from .37 to .51. Black students' third semester enrollment status was better predicted than Whites. Results demonstrated

the NCQ added predictive power beyond that contained in the SAT and that Whites and Blacks differed in predictability of GPA and retention from aptitude and noncognitive variables.

Tracey and Sedlacek (1985) continued their exploration of comparing noncognitive variables' utility in predicting college performance for Black and White students. This longitudinal study considered the association between Noncognitive Questionnaire (NCQ) variables, developed by Sedlacek and Brooks (1976), and college GPA after one, three, five, six, and eight semesters. The participants were incoming freshmen ($N = $ 2,742) at a large eastern university in 1979 ($n = $ 1,995; 1,752 Whites and 243 Blacks) and 1980 ($n = $ 747; 571 Whites and 176 Blacks). Participants completed the NCQ during summer orientation before their freshmen year.

The 23-item NCQ contained two nominal items, 18 items measured on a Likert-type scale, and three open-ended questions. Median test-retest reliability was .85 for all items. Three raters, with intercorrelations ranging from .83 to 1.00, converted the open-ended responses into interval-level variables. Principal components factor analyses, conducted by race on the NCQ data to assess construct validity, demonstrated support for the following variables: (a) leadership, (b) recognizing racism, (c) preference for long-range goals, (d) realistic self-appraisal, (e) support for college plans, (f) self-confidence, (g) community service, and (h) academic familiarity. The predictor variables for the stepwise multiple regression analyses were the individual NCQ items and SAT score. Tracey and Sedlacek conducted separate regression analyses by race and year group for each semester GPA criterion and discriminate analyses by race and year group for enrollment status at three, five, six, and eight semesters.

Tracey and Sedlacek (1985) reported all regression models, with one exception for the 1980 Black group, significantly ($p < .05$) predicted GPA at each interval considered and remained relatively stable over time. When combined with SAT, noncognitive variables added predictive power to the model at all levels for both races. Self-confidence, realistic self-appraisal, and community service were the most frequent NCQ contributors in accounting for GPA variance. For enrollment status, NCQ were better predictors than SAT scores and better predictors for Blacks than Whites. SAT scores added little to the combined equation. Canonical correlations ranged from .19 to .49 for Blacks and from .18 and .28 for Whites. Whites' persistence related to self-confidence. Blacks' persistence related to self-confidence, realistic self-appraisal, support, and community service. Tracey and Sedlacek's results indicated Black students' college success and persistence in a predominantly White educational environment were significantly related to noncognitive variables.

Tracey and Sedlacek (1987a) furthered examined the similarities and differences in the process of educational attainment between White and Black students by analyzing the structural relation of noncognitive variables and a traditional academic ability measure, SAT score, to first semester college grade point average (GPA) and persistence after three and five semesters. Participants were incoming freshmen ($N = 1,683$) at a large, predominantly White, eastern university in 1979 and 1980. The sample contained 208 Black students and 1,475 White students. Participants completed the Noncognitive Questionnaire (NCQ) during summer orientation before their freshmen year.

The 23-item NCQ contained two nominal items, 18 items measured on a Likert-type scale, and three open-ended questions. Median test-retest reliability was .85 for all items.

Two raters, with intercorrelations ranging from .83 to 1.00, converted the open-ended responses into interval-level variables. Principal components factor analyses demonstrated support for the following constructs: (a) Leadership, (b) Recognizing Racism, (c) Preference for Long-range Goals, (d) Realistic Self-appraisal, (e) Support for College Plans, (f) Self-confidence, and (g) Community Service. Tracey and Sedlacek selected 16 NCQ items to represent the seven noncognitive factors for inclusion in the analysis. SAT-Verbal and SAT-Quantitative scores were the aptitude predictors. The researchers used LISREL VI, Analysis of Linear Structural Relationships by the Method of Maximum Likelihood, to analyze the data. The criterion measures were first semester GPA and enrollment status after one and three semesters.

The statistical tests for goodness of fit for both Black and White sample was significant ($p < .001$). For White students, SAT scores and self-concept best predicted first semester GPA. GPA, in turn, best predicted enrollment status. For Black students, SAT scores best predicted first semester GPA. Conversely, GPA for Black students was not related to persistence. Black persistence related to noncognitive factors. Tracey and Sedlacek's (1987a) findings indicated significant differences in the factors and influences affecting persistence of White and Black students.

Tracey and Sedlacek (1987b) next examined the validity of noncognitive dimensions as predictors of graduation for Black and White students in a study exploring racial differences in persistence and graduation rates unaccounted for by traditional ability measures. The study's participants were freshmen ($N = 1,766$) entering a large, predominantly White, eastern state university in 1979 and 1980. The sample consisted of

1,262 freshmen from 1979 (1,137 Whites, 125 Blacks) and 504 freshmen from 1980 (415 Whites, 89 Blacks). Each participant completed the Noncognitive Questionnaire (NCQ).

The NCQ assessed seven factors hypothesized by Sedlacek and Brooks (1976) to contribute to academic success for minority students. The NCQ included 23 items consisting of two categorical items on educational aspirations, 18 Likert-type items on expectations and self-assessment, and three open-ended questions on goals, accomplishments, and activities. Test-retest reliability for items ranged from .70 - .94. Two judges rated the open-ended questions. Interrater reliability correlations ranged from .83 – 1.00. The resultant variables were: (a) long-range goals, (b) academic relatedness of goals, (c) degree of difficulty of listed accomplishments, (d) overall number of outside activities, (e) leadership, (f) academic relatedness of activities, and (g) community involvement. Factor analysis revealed eight factors closely approximating the seven defined by Sedlacek and Brooks (1976). The eight predictor factors were: (a) self-assessment of academic motivation, (b) perseverance, (c) leadership, (d) academic self-concept, (e) long-range academic goals, (f) community service, (g) support for academic plans, and (h) expected difficulty. Factor loading for expected difficulty varied between Blacks and Whites. The researchers created a separate difficulty factor for each race. SAT scores were also predictors. The criterion variable was graduation status as of July 1985.

A *z* test of the difference between graduation rates for Whites and Blacks in both 1979 and 1980 year groups indicated White students graduated at significantly higher rates than Blacks. Separate stepwise discriminant analyses for each Year x Race subgroup yielded better predictive power for Blacks than Whites. More NCQ factors related to

graduation for Blacks than Whites. Tracey and Sedlacek (1987b) reported two significant implications: (a) Blacks take longer to graduate from predominantly White institutions, and (b) Blacks' graduation rates are more predictable using noncognitive factors. Returning to a concentration on academic predictors, Lawlor, Richman, and Richman looked for significant differences between Whites and Blacks at Wake Forest University.

A study by Lawlor, Richman, and Richman (1997) tested the unbiased validity of the SAT as a predictor of college performance for African-Americans and European-Americans. The study participants were Wake Forest University (WFU) freshmen ($N = 348$) in 1990 and graduated from WFU in 1994. The sample contained 21 African-Americans and 327 European-Americans evenly split by gender.

The researchers selected the following interval-level predictor variables: (a) SAT-Total, SAT-Math, and SAT-Verbal scores, (b) high school GPA, and (c) high school percentile class rank. The criterion variables were college GPA and college graduating class percentile rank. Data analysis included stepwise multiple regression for White students and correlations, due to insufficient numbers for regression, for African-Americans.

Multiple regression revealed high school GPA was the strongest predictor of college GPA and graduating class rank. SAT-Total did not add significantly to either model. When SAT-Math and SAT-Verbal substituted for SAT-Total, SAT-Verbal was the strongest predictor of both criterion measures. High school GPA added predictive power to both models. SAT-Verbal correlated significantly with college GPA and graduating class rank for Black and White students (r's = .33 and r's = .61, respectively). SAT-

Math was not correlated significantly to either criterion measure for Blacks or Whites. Black and White students' SAT-Math and SAT-Total scores differed significantly ($p < .001$). No other variables revealed statistically significant differences between Blacks and Whites at the .05 level. The lack of a multiple regression model for Blacks hindered data interpretation. Significantly different SAT scores between Blacks and Whites, lacking indications of resultant differences in academic performance, merited further study.

An investigation by Ting and Robinson (1998) assessed the predictive validity of four cognitive predictors and 39 psychosocial and demographic predictors on college grade point average and retention. The research question, disaggregated by gender and race, focused on discovering the efficacy of the Noncognitive Questionnaire (Tracey and Sedlacek, 1984) and the First Year Student Survey (FYSS), developed by Ting, as predictors of academic performance and retention. The study participants were freshmen ($N = 2,600$) at a large Southeastern public research university.

Predictor variables were measured at the interval level or dummy coded for inclusion in the regression computations. The four cognitive predictors were high school GPA, SAT-Verbal (SAT-V) score, SAT-Mathematics (SAT-M), and SAT-Total (SAT-T). The eight NCQ variables were positive self-concept, realistic self-appraisal, community service, knowledge acquired in a field, successful leadership experience, preference for long-range goals, ability to understand and cope with racism, and availability of support person. The 12 FYSS variables were: (a) analytical ability; (b) appreciation of arts, music, and literature; (c) communication skills; (d) contact with the university in the admissions process; (e) sensitivity to diversity; (f) consideration of resources and support

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of academic programs; (g) importance of personal development; (h) level of personal development; (i) responsibility and development of the world; (j) importance of science development; (k) science skills; and (l) importance of understanding world cultures. The demographic predictors were age, housing type, financial aid, musical ability, intention to join extracurricular activities, number of colleges applied, certainty of major, intent for highest level of education, time to complete first degree, course load, dependents in parents' family, types of living area in high school, planning for work hours, father's educational level, and mother's educational level. The four criterion variables were fall GPA, spring GPA, fall retention, and spring retention. The researchers used step-wise multiple regression analyses for the entire sample, then separately for subgroups divided by gender and race. Due to participant numbers, the regression analyses for African-Americans did not utilize FYSS or demographic data.

The fall GPA multiple regression results for the entire sample reported by Ting and Robinson (1998) included significant predictors ($p < .001$) from each category and yielded an R-square of .20. Additional regression models and associated R-square values are as follows: (a) all males, .19; (b) all females, .23; (c) Caucasian males, .18; (d) Caucasian females, .25; (e) African-American males, .29; and (f) African-American females, .08. The spring GPA multiple regression results produced similar results. The regression model for retention of all students yielded an R-square of .015. In summary, high school GPA was the most significant predictor of GPA. Gender and race influenced predictor significance. The study's results supported the use of multiple predictor models for improved accuracy across race and gender.

Summary. Significant differences existed between Blacks and Whites in regards to the prediction of college GPA and persistence. Universal prediction equations were most accurate for White students, less accurate for Black females, and poor predictors for Black males (Cleary, 1968; Sampel & Seymour, 1971). Aptitude measures tended to underpredict Black students' grades. High school GPA and high school class rank were more consistent predictors for both races than aptitude variables (Nettles, Thoeny, & Gosman, 1986; Sandord, 1982). Numerous studies by Tracey and Sedlacek (1984, 1985, 1987a, 1987b) supported the use of noncognitive variables to improve prediction results.

Multiple Racial Comparisons

Perry (1981) compared the college academic performance and persistence of Mexican-Americans, Blacks, and Whites using two sets of factors: college life and high school performance. The importance of equal opportunity and access for minority students in postsecondary institutions undergirded this study. The sample ($N = 3815$) consisted of Black ($n = 216$), Mexican-American ($n = 397$), and White ($n = 3202$) students at Texas Tech University (TTU).

The college life predictor variables Perry (1981) selected were degree aspiration, professional school status, sex, residency status, method of entrance, scholarship status, government benefit status, social organization membership, church membership, and housing. The high school predictors were SAT-Verbal score, SAT-Mathematics score, high school size, and high school GPA. The dependent variables were college GPA and persistence. Persisters remained enrolled at the university throughout the study period, 1970-1974. Perry used multiple regression to analyze the data.

Results indicated numerous college life variables correlated significantly with college GPA, but accounted for relatively little variance when compared to SAT scores and high school GPA. Multiple regression results predicting persistence revealed significant relationships with variables in unexpected directions. College persistence was associated with low degree aspirations, enrollment in nonprofessional schools (i.e., Arts and Sciences), entrance from other than high school (i.e., veterans, housewives, transfers), non-membership in sororities and fraternities, off-campus housing, and low college grades. High school variables were the best predictors of college GPA. R-square for the GPA model was .451. Sex, high school GPA, and college GPA were the statistically significant ($p < .05$) predictors of persistence. R-square for the persistence model was .233.

When compared by race, the proportion of variance accounted for in GPA and persistence was relatively small for all three groups. Notable differences were a correlation between church membership and low grades for Blacks and a correlation between high degree aspirations and low persistence for Mexican-Americans. Perry's (1981) findings indicated college GPA and persistence are separate phenomena with unique predictors.

A study by Ott (1988) analyzed the predictors of academic dismissal after one semester for first-time freshmen. Ott's focus was on taking the first steps toward developing a model, based on selected aspects of Tinto's (1975) model of college dropout, of academic dismissal (involuntary dismissal for poor grades). The participants were White, Black, and Asian freshmen in the falls of 1984 ($n = 507$) and 1985 ($n = 455$). Each year's sample consisted of academically dismissed (AD) and academically

proficient (SP) students. In both years, approximately four percent of freshmen were academically dismissed after one semester and were in the sample population. AD students in 1984 numbered 165. AD students in 1985 numbered 172. A ten percent random selection of SP students completed each year's sample.

Ott (1988) utilized ability, demographic, and college environment predictor variables. The interval-level ability predictors were SAT-Verbal (SATV) score, SAT-Mathematics (SATM) score, and high school grade point average (HSGPA). The categorical demographic variables were race (Black, Asian, or White) and sex. The categorical college environment predictors were Dorm (resident or commuter), FPTIME (full-time or part-time student status), and Group. Group, the academic grouping of a student's major, was either Agricultural and Life Sciences (ALSC), Arts and Humanities (ARHU), Behavioral and Social Sciences (BSOS), Human and Community Resources (HUCR), Mathematical and Physical Sciences and Engineering (MPSE), or Undergraduate Studies (UGST). Ott employed separate logistic regressions for each year's sample to predict the criterion variable, AD or SP status.

Independent t-tests revealed significant ($p < .01$) differences between SP and AD students on SATV, SATM, and HSGPA means. SATM for the 1984 cohort was the one ability measure not significantly different. Controlling for these differences by forced entry, the remaining predictors entered in stepwise fashion. Results for both year groups were consistent. HSGPA was the most significant ($p < .001$) predictor. Race and Group entered the equation as significant contributors. Sex, Dorm, and FPTIME did not contribute to the equation. Post hoc analysis revealed the significant difference on Race existed between Blacks and the other two groups, Whites and Asians. Blacks, with

ability and Group variables controlled, were more likely to encounter academic failure. With Race and ability variables controlled, students in ALSC and MPSE were more likely to encounter academic failure. Ott's (1988) results indicated certain students are at greater risk for academic failure in the first semester than others. Black students, students with low HSGPAs, and students in two academic groupings were academically dismissed at a rate significantly higher than their fellow students.

Rovezzi-Carroll and Thompson (1980) analyzed the utility of four variables in predicting college persistence among low-income minority students. The researchers sought to validate the ability of selective admissions procedures using SAT scores and high school rank in predicting academic success for this population of students. The study participants ($N = 104$) were Talent Assistance Cooperative (TAC) students entering two- or four-year postsecondary institutions between 1968 and 1975. TAC was a federally-funded program designed to assist low-income students attain postsecondary education. The sample contained 73 minority students (Blacks and Hispanics) and 31 White students.

The continuous independent variables were SAT-Math score, SAT-Verbal score, high school percentile rank, and annual family income. The nominal dependent variable was enrollment status (graduated, withdrawn, or academically dismissed) in the fall of 1977. Rovezzi-Carroll and Thompson (1980) performed a preliminary multivariate analysis of variance (MANOVA), using enrollment status as the independent variable and the predictors as the dependent variables, then followed with a discriminant analysis.

The results of the MANOVA were not statistically significant ($p < .05$). The three categories of TAC students did not differ significantly on the four dependent measures.

Due to the exploratory nature of their inquiry, Rovezzi-Thompson and Carroll (1980) proceeded with the discriminant analysis. The resultant discriminant functions were not significant at the .05 level. SAT scores, high school rank, and annual family income did not significantly differentiate between graduates, withdrawals, and dismissals.

A study by Arbona and Novy (1990) assessed the validity of aptitude test scores and noncognitive factors as grade and persistence predictors. The study's focus was the examination of the predictive ability of traditional academic variables and noncognitive variables for Black, Mexican-American, and White students. The participants were incoming freshmen ($N = 746$) in 1987 to a large state university in the Midwest. The ethnic breakdown was 95 Blacks, 96 Mexican-Americans, and 555 Whites.

The predictor variables were eight factors from the Noncognitive Questionnaire (NCQ), SAT-Math (SAT-M) score, and SAT-Verbal (SAT-V) score. Arbona and Novy performed a factor analysis on the NCQ data. Factor analysis indicated the following eight subscales: (a) Certainty of Academic Plans (CPLANBW = Blacks and Whites, CPLANMA = Mexican-Americans); (b) Support for College Plans (SUPP); (c) Community Involvement (COMM); (d) Long-term Academic Goals (LTAG); (e) Perseverance (PERS); (f) Expected Academic Difficulty (EXPDIFF); (g) Academic Familiarity (ACADFAM); and (h) Leadership (LEAD). Internal consistency reliabilities, computed for each race on each factor, ranged from a low of .19 for Whites on CPLANBW to a high of .84 for Mexican-Americans on SUPP. The NCQ contained two categorical items, 18 5-point Likert-type items, and three open-ended questions. Test-retest reliability, reported by the NCQ developers, Tracey and Sedlacek (1984), ranged

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from .70 - .94 for each item. The criterion variables were freshman GPA and enrollment status (persistence) at the beginning of the sophomore year.

Arbona and Novy (1990) performed a hierarchical multiple regression analysis for each ethnic subsample to predict GPA. They performed a discriminant analysis for each ethnic group to predict persistence. SAT scores entered the equations first. No factors significantly predicted Black students' GPAs. SAT-M and CPLANMA were significant predictors of Mexican-Americans' GPAs. SAT-V, SAT-M, and ACADFAM were significant predictors of White students' GPAs. No factors significantly predicted persistence for Blacks or Mexican-Americans. For Whites, SUPP, COMM, LTAG, and ACADFAM were significant predictors of persistence. Arbona and Novy's results were not wholly consistent with previous NCQ research of grades and persistence among ethnic subsamples.

House (1996) studied the efficacy of noncognitive variables and academic background in predicting college grades and persistence among minority students. The sample ($N =$ 9,589) came from four consecutive freshmen classes at a university. There were 4,254 males, 5,335 females, 251 Hispanics, 378 Asian-Americans, 644 African-Americans, 15 Native-Americans, and 8,301 Whites. Participants completed the Cooperative Institutional Research Program Freshmen Survey (CIRP) prior to fall classes their freshman year.

The interval-level predictor variables were seven CIRP noncognitive measures (achievement expectancies, academic self-concept, financial goals, social goals, desire for recognition, parental education, and high school curriculum) and two academic background variables (ACT score and high school class percentile rank). Five dependent

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variables included the interval-level measures of college GPA after one, two, and four years, plus the nominal-level variables of enrollment status after two and four years. House analyzed the data three ways: (a) correlation coefficients summarized the relationship between predictors and criterion measures, (b) ordinary least-squares regression analyses investigated the contributions of predictors to GPA measures, and (c) stepwise logistic regression analyses determined the relative ordering of predictors toward explaining persistence variance. The researcher conducted each regression procedure for the entire sample and separately for each ethnic group except, due to insufficient numbers, Native-Americans.

High school PR and ACT score correlated significantly with all dependent measures. Four CIRP variables (academic self-concept, achievement expectancies, high school curriculum, and parental) were significantly positively correlated with all dependent measures. The remaining CIRP variables (financial goals, social goals, and desire for recognition) were significantly negatively correlated with both persistence measures. Ethnic groups differed on predictor significance.

The GPA-after-one-year multiple regression analysis for the entire sample indicated both the academic background variables were the most significant contributors. Parental education, academic self-concept, and financial goals entered the equation to yield an R-square value of .276, significant at the .0001 level. The GPA-after-two-years multiple regression analysis for the entire sample provided similar results, with the addition of financial goals and high school curriculum, to yield an R-square value of .286, significant at the .0001 level. The GPA-after-four-years multiple regression analysis for the entire sample included six variables and yielded an R-square value of .271, significant at the

.0001 level. Each ethnic group regression analysis by GPA measure was significant at the .001 level.

House (1996) performed the persistence logistic regression analyses by ethnic group. For two year persistence, both academic background variables entered the equation first except for Hispanic students. The regression model was not statistically significant for Hispanics. The two-year persistence regression models for Whites, African-Americans, and Asian-Americans were significant at the .0001 level. The four-year-persistence models yielded similar results. The regression model was not statistically significant for Hispanics. The regression models for Whites ($p < .001$), African-Americans ($p < .001$), and Asian-Americans ($p < .05$) were statistically significant at the indicated levels.

A 1997 study by Young and Koplow investigated the overprediction of minority student college grades by traditional measures using two noncognitive questionnaires. Overprediction occurs when students' actual grades are lower than those predicted by a regression equation common to all students. Young and Koplow designed their study to test certain nonacademic, noncognitive constructs' abilities to eliminate overprediction. The participants were 790 fourth-year undergraduates (233 African-Americans, 193 Hispanic-Americans, and 364 Whites) at a large mid-Atlantic state university who had initially enrolled in the fall of 1990, had earned a minimum of 60 credit hours, and were enrolled in one of the liberal arts colleges.

Participants completed two mailed surveys during their fourth year. A 27.1% response rate resulted in a sample of 214 respondents. African-Americans and students with lower cumulative grade point averages (GPA), lower high school percentile ranks, and lower SAT scores responded at a significantly lower rate. The two questionnaires,

both utilizing Likert-type scales, were the 67-item Student Adaptation to College Questionnaire (SACQ) and the 36-item Non-Cognitive Questionnaire, Revised (NCQR). The SACQ yielded four predictor subscales: (a) academic adjustment, (b) social adjustment, (c) personal-emotional adjustment, and (d) attachment. The NCQR's eight predictor subscales were: (a) academic positive self-concept, (b) realistic self appraisal, (c) support of academic plans, (d) leadership, (e) long range goals, (f) ability to establish community ties, (g) understanding of racism, and (h) academic familiarity. College records provided high school percentile rank (HSPR), SAT-Verbal (SAT-V) score, and SAT-Mathematics (SAT-M) score as aptitude and achievement predictor variables. The criterion variable was cumulative college GPA (CUMGPA).

Young and Koplow (1997) reported a significant ($p < .02$) overestimation of minority students CUMGPA by .12 points using preadmission measures (SAT-V, SAT-M, and HSPR). R-square for the model was .22. Stepwise multiple regression analysis using all predictor variables yielded three significant predictors (SAT-V, HSPR, and SACQ academic adjustment) and an R-square value of .33, a significant increase ($p < .002$) of 52% over the first model. Results indicated that prediction of minority grades significantly improves with the inclusion of a noncognitive self-reported measure of academic adjustment.

Strage (2000) sought to identify the unique predictors of college adjustment and success among Southeast-Asian-American, Hispanic, and White students. The study analyzed relationships among student grades, motivational profiles, family background, and ratings of rapport with instructors and peers. The study participants were students ($N = 150$) at a large metropolitan university in California. The sample included 73 White

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students, 40 Southeast-Asian-American students, and 37 Hispanic students. The sample was predominantly female ($n = 132$), commuter ($n = 130$), and Child Development majors ($n = 120$).

Participants completed the Student Attitudes and Perceptions Survey (SAPS). SAPS yielded family background variables for socioeconomic status (SES) and educational attainment. Participant ratings on family values and parenting styles yielded the three scales scores of autonomy granting, demandingness, and supportiveness. Reliability coefficients for the three scales among ethnic groups ranged from .50 to .79. Participant ratings on achievement motivation items yielded the three scale scores of confidence, persistence, and task involvement. Reliability coefficients for the three scales among ethnic groups ranged from .52 to .86. Participant ratings on adjustment to college life items yielded the two scale scores of teacher rapport and peer rapport. Reliability ranged from .61 to .86. Cumulative GPA and major's GPA were also recorded as variables.

Strage (2000) conducted a one-way multivariate analysis of variance (MANOVA) with ethnicity as the independent variable and the following five dependent variables: (a) cumulative GPA, (b) major's GPA, and (c) the three scale scores for achievement motivation. The overall main effect for ethnicity was significant ($p < .05$). White student earned higher grades, cumulative and in their major, than either ethnic group. Southeast-Asian-Americans displayed the lowest scores on the three achievement motivation scales. A second MANOVA, with ethnicity as the independent variable and the SES, educational attainment, and three parenting style scales as dependent variables, revealed a significant ($p < .001$) main effect for ethnicity. SES, parental education level, and first person in family at college differed significantly among groups. Whites and Hispanics rated

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parents significantly ($p < .05$) higher on autonomy granting and supportiveness than Southeast-Asian-Americans. A third MANOVA, with ethnicity as the independent variable and the three college adjustment scales as dependent variables, yielded no significant main effect.

Correlational analysis indicated significant relationships among variables. Teacher rapport was significantly related to all five measures of success and adjustment. Results supported a systematic relationship between the five indices of success (cumulative GPA, major's GPA, and three scales scores for adjustment) and respondent's family background. Ethnic differences, impacting success and persistence measures, supported Strage's attention to family and background variables' impact on student performance.

Summary. The prediction of academic performance and persistence in college was highly associated with race. High school variables (e.g., GPA and rank) were consistently the best predictors for all races (Perry, 1981; Ott, 1988). When regression analyses grouped races together, Black student grades were least predictable (Arbona & Novy, 1990; House, 1996). Noncognitive factors improved prediction across ethnic lines (Young & Koplow, 1997) as did the inclusion of demographic and family variables (Strage, 2000).

In general, research on the prediction of college success, with the variable of interest as race or ethnicity, indicated significant differences in preparation for college (Thomas & Stanley, 1969), college performance, and graduation rates (Tracey & Sedlacek, 1987; Young & Koplow, 1997). This body of research on racial differences in academic prediction led to a number of supported conclusions. First, Black student academic performance at Black institutions was comparably predicted by traditional measures as

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White students' grades at White institutions (Stanley & Porter, 1967). Second, minority performance at predominantly White institutions was a separate situation where noncognitive variables may hold potential value for increasing predictive power for minority criteria (Tracey & Sedlacek, 1984; House, 1996). Institutions that used one prediction equation for all races underestimated the prediction of some students' grades and overestimate the grades of others (Cleary, 1968; Young & Koplow, 1997). Finally, there were differences in pre-admission characteristics across ethnic lines (e.g., Whites, Blacks, Hispanics, Native Americans, Asians, etc.). These differences demand consideration when admission officials and college administrations make decisions that impact students' futures (Hawkins, 1989). This body of literature strongly supported race as a significant moderating factor in the prediction of academic success. Another variable, which interacts with race and moderates the prediction of college academic performance, is gender.

Prediction by Gender

As prediction validity varied across ethnic and racial lines in the discussion above, gender significantly influences predictability and variable significance in the research reviewed below. The main body of literature focuses on the greater predictability of women's grades and persistence in college (Seashore, 1962; Bean, 1980). Researchers also examined the predictability of each gender across racial lines (Houston, 1980; Kanoy, Wester, & Latta, 1989; Ancis & Sedlacek, 1997). A final area of study was the relative importance of specific variables (e.g., high school performance, nonintellective, aptitude test score) to the prediction of each gender's performance in college (Gross, Faggen, & McCarthy, 1974; Spiegel & Keith-Spiegel, 1971). If a postsecondary

institution seeks to maximize the opportunities for student success, administrators must understand the unique factors impacting each gender's performance and persistence (Baker & Velez, 1996). Three subdivisions compose this section: (a) the prediction of first year college GPA, (b) the prediction of cumulative college GPA, and (c) the prediction of college persistence.

Prediction of First Year College GPA with Gender

Seashore (1962) reviewed past study findings on academic performance prediction and concluded that women were more predictable than men. His conclusions are split between prediction of high school grades and prediction of college grades. Using data from Bennett, Seashore, and Wesman's 1959 *Differential Aptitude Tests Manual*, Seashore compared 520 sets of high school student paired validity coefficients between Differential Aptitude Test subject tests (verbal reasoning, numerical ability, abstract reasoning, space relations, mechanical reasoning, clerical speed and accuracy, spelling, and sentences) and grades in three high school subject areas (English, Social Studies, and Math-Science). Girls' grades were more highly correlated to aptitude test scores on 61% of the comparisons. Thirteen percent of the comparisons were significantly different at the .10 level. Seventy-one percent of these significant differences favored greater predictability for girls' grades.

Seashore's (1962) analysis of validity coefficients for college grades supported an even wider gap between sexes favoring better predictability of women's grades. Comparisons of validity coefficients between college grades and six scores of the College Qualification Tests indicated women's grades were more predictable 69% of the time. Of the differences significant at the .10 level, women's validity coefficients were higher on

83% of the comparisons. Seashore concluded that women's grades, both in high school and college, were more predictable than men's grades by aptitude test scores.

Paraskevopoulos and Robinson (1970) compared the regression equations predicting college performance from high school record and admissions test scores for males and females. Their study tested the hypotheses that the predictive regression equation's slope, intercept, or both would differ significantly between males and females. Participants were freshmen ($N = 7,196$) enrolled in the College of Liberal Arts and Sciences at the University of Illinois. Data from the freshmen at the Urbana-Champaign (U-C) campus in 1965 ($n = 2,690$) and 1966 ($n = 2,603$) were combined with data from freshmen at the Chicago Circle (CC) campus in 1966 ($n = 1,903$).

The researchers used two predictor variables. An equation using high school graduation class size and class rank yielded high school percentile rank (HSPR). The ACT-Composite score (ACT-C) was the second predictor. The interval-level criterion variable was the unweighted average of quality points, from the University of Illinois' five-point grading scale, for grades earned on first term courses.

Paraskevopoulos and Robinson (1970) computed nine regression equations, three (males, females, and combined) for each campus subgroup (U-C 1965, U-C 1966, and CC 1966). The differences between male and female regression coefficients were not significant. The criterion intercepts for males and females were statistically significant at the .01 level. Multiple R for all nine regression equations ranged from .46 to .55.

Across the three campus subgroups, a combined regression equation overestimated male GPA, underestimated female GPA, or both. A common prediction equation for males and females favored male applicants. Separate equations, based on gender specific

data, predicted GPAs approximately .2 higher for females than males for the same high school rank and test scores.

Gross, Faggen, and McCarthy (1974) followed a similar line of research as Paraskevopolous and Robinson (1970) by examining the differential predictability of college grades by sex. Their research design used six variables to predict college freshman GPA for 17,745 students enrolled at ten of the colleges under the City University of New York (CUNY). A heterogeneous sample resulted from CUNY's open admission policy for New York City high school graduates.

The six predictor variables included two achievement test measures (Stanford Achievement Test-Mathematics and Verbal) and the average grades in the following high school subject areas: (a) English, (b) math, (c) science, and (d) social studies. The criterion was freshman cumulative GPA. Gross et al. (1974) computed male and female regression equations for each of the ten CUNY colleges and then applied that equation to a cross-validation sample from the same school. In nine of the ten schools, female grades were more highly correlated with the predictors than male grades. The difference in the multiple R values ranged from .03 to .39. The results reported by Gross, Faggen, and McCarthy (1974), based on the sample size and heterogeneity, provided substantial support to the hypothesis that the academic achievement of females is more predictable than males.

Kanoy, Wester, and Latta (1989) focused on White females in comparing the contributions of traditional and nontraditional measures in predicting first year college GPA. The investigators expected the best prediction model would contain both traditional and nontraditional predictors. The sample consisted of freshman females (N =

70) entering Peace College, a two-year liberal arts college. The researchers selected the participants based upon a formula provided by the Educational Testing Service and used by the Peace College admissions office. The sample was split into high-achieving Group A ($n = 36$), with predicted GPAs between 2.90 and 3.66, and low-achieving Group B ($n = 34$), with predicted GPAs between 1.80 and 2.08. Participants completed the Multidimensional-Multiattributional Causality Scale (MMCS), the Learning Context Questionnaire (LCQ), and the Academic Self-Concept Scale.

The interval traditional predictors were SAT-Verbal score, SAT-Math score, high school GPA, and score on the Test of Standard Written English test (TSWE). The nontraditional predictors were the following interval-level measures from the three instruments: (a) achievement success locus of control, (b) achievement failure locus of control, (c) academic self-concept, (d) cognitive complexity, (e) ability for academic work, and (f) effort put into academics. The criterion was freshman year GPA. Kanoy, Wester, and Latta (1989) performed two regression analyses for each group. The first analysis used only traditional predictors. The second analysis used all the predictors.

The regression analysis for high-achieving Group A using only traditional predictors resulted in an R^2 value of .50, significant at the .05 level. Sat-Verbal score, high school GPA, and TSWE were significant ($p < .10$) contributors. The regression analysis for low-achieving Group B produced a nonsignificant R^2 of .22. The second set of regression analyses, with both sets of predictors, produced statistically significant ($p < .01$) prediction equations for both groups. The equation for Group A, with high school GPA and academic self-concept as contributors, yielded an R^2 of .56. Achievement success and effort contributed to Group B's R^2 of .46. The results reported by Kanoy et al. (1989)

indicated an inadequacy of traditional academic measures in predicting college performance for lower performing female students. Nontraditional measures were significant contributors to the prediction equations for this population of students.

Spiegel and Keith-Spiegel (1971) explored the predictive potential of combining intellectual, attitude, and personality variables on first year college students' grades. Participants were 18- and 19-year-old college students ($N = 76$) in an introductory psychology class. The sample was composed of 45 males and 31 females.

Fifty-four predictor variables, recorded at the beginning of the semester, came from the following tests and scales: (a) the Manifest Anxiety Scale, (b) the Custodial Mental Illness Ideology Scale, (c) the California F Scale, (d) the 15-item short form of the Overall Agreement Scale, (e) the Dogmatism Scale, (f) the Security-Insecurity Inventory, (g) the Internal-External Control Scale, (h) the Institute of Living Scale vocabulary and abstractions subtests, (i) the Picture Differences Test, and (j) the Spiegel Personality Inventory with 42 scales. The criterion variable was an interval-level measure of total course points earned.

The researchers utilized stepwise regression to select the linear combination of variables to optimize prediction of total course points for males and females separately. Variables entering the regression model required an F value greater than 2 and an R^2 contribution greater than .03. The predictor set for males contained 12 variables (vocabulary, custodial view of mental illness, serious disposition, social insecurity, deviant response, change minimizing, alienation, external locus of control, physical inactivity, auditory minimizing, impulsive action, and spatial confinement) to yield a multiple R of .85, significant at the .001 level. The regression model for females

contained ten variables (identification with mother's values, anger-depression, risk taking, rapid identification of picture differences, social minimizing, deviant response, warm weather minimizing, intrusive thought, obsessiveness, and dependency) to yield a multiple R of .92, significant at the .001 level.

Spiegel and Keith-Spiegel (1971) highlighted the differences between the regression models for each gender. The regression model for females contained fewer variables, different variables, and accounted for greater variance in the criterion than did the regression for males. Personality and attitude information was useful in predicting performance in college. Gender differences held particular promise for further investigation.

Summary. Gender strongly moderated the prediction of first year college GPA in the preceding studies. Females' grades tended to be underestimated by universal prediction equations (Paraskevopoulos & Robinson, 1970) and more highly correlated high school predictors (Gross, Faggen, & McCarthy). The addition of nonintellective (e.g., attitudinal, personality, noncognitive) factors to the regression equation improved prediction significantly (Kanoy, Wester, & Latta, 1989; Spiegel & Keith-Spiegel, 1971).

Prediction of Cumulative GPA with Gender

Houston (1980) assessed the extent to which predictor variables contributed to the prediction of college GPA for specially admitted Black females ($N = 61$) at Douglass College, Rutgers University, in 1976. Each participant was initially denied admission for failure to meet minimum admission criteria, but was subsequently granted a 'special admission'. Houston's primary focus was on gathering evidence to reduce the number of minority admissions decisions classified as 'false negatives', rejecting applicants with

low aptitude test scores but who possess the academic ability, motivation, and skills to succeed in the college environment. Houston hypothesized that high school rank (HSR) would be the strongest predictor of academic success in college and that graduates and non-graduates would differ significantly on HSR, but not on SAT scores.

Houston's (1980) predictor variables for the multiple regression were SAT-Verbal score, SAT-Mathematics score, and HSR. The criterion variable was cumulative GPA after eight semesters. Graduation status was recorded for mean comparisons. The two groups of students, graduated ($n = 41$) and academically dismissed ($n = 20$), differed significantly on SAT-Mathematics score ($p < .05$), HSR ($p < .02$), and college GPA ($p < .0001$). The results of the multiple regression analysis indicated HSR was the best predictor ($R^2 = .14$), with SAT-Verbal and SAT-Mathematics adding R^2 increments of .07 and .01, respectively. Though 22% of the variance in GPA after 8 semesters was accounted for by the variables Houston (1980) selected, the remaining 78% of unexplained variance highlighted the need for additional study in the prediction of college success for this population of Black females.

Ancis and Sedlacek (1997) examined the predictive validity of the noncognitive questionnaire (NCQ) and SAT scores on women's academic achievement throughout college. The sample ($N = 1,930$) was composed of Asian-Americans (6%), African Americans (12%), Hispanics (4%), and European Americans (78%). The participants were entering freshmen at a large, mid-Atlantic university over a ten-year period from 1979 to 1988.

The 23-item NCQ (18 Likert-type items, two nominal items, and 3 open-ended questions) produced the following eight noncognitive, interval-level predictor variables:

(a) positive self-concept, (b) realistic self-appraisal, (c) understands racism, (d) prefers long-range goals, (e) support person, (f) leadership experience, (g) community service, and (h) nontraditional knowledge. SAT-Verbal and SAT-Mathematics scores were also predictors. The criterion variables were cumulative GPA at each of the seven semesters.

Ancis and Sedlacek (1997) reported significant zero-order correlations between the predictors and the criterion for semesters 1, 3, 5, and 7. SAT-Verbal score, SAT-Mathematics score, realistic self-appraisal, support person, leadership experience, community service, and nontraditional knowledge were significantly correlated at each semester. The long-range goals variable failed to be a significant predictor during any semester. Stepwise multiple regression analyses for semesters 1, 3, 5, and 7 produced multiple R values of .36, .37, .36, and .30, respectively. Both SAT scores were consistently strong contributors to the equations. Demonstrated community service was the strongest NCQ predictor for each semester. Realistic self-appraisal and nontraditional knowledge were also significant predictors in each equation. Ancis and Sedlacek's (1997) results provided information to college administrators on the interrelationship between cognitive and noncognitive variables' predictive validity of women's academic performance in college.

Sexton and Goldman (1975) examined the relationship of high school preparation to college major-field selection and success. Using nonreactive measures from the high school transcript, the researchers sought to uncover any association between college major or college success and the number of high school course taken in specific subjects. Participants were students ($N = 429$) attending the University of California, Riverside, during the winter quarter of 1973. Twenty-five percent of the freshmen and junior

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students from the five campus colleges (Physical Sciences (PS), $n = 48$; Biological Sciences (BS), $n = 93$; Social Science (SS), $n = 140$; Humanities (HM), $n = 85$; and Undergraduate Studies (US), $n = 63$) were randomly selected.

Sexton and Goldman gathered data from the college's records and participants' high school transcript. The dual multivariate 2x5x5 analysis of variance (ANOVA) design used the following nominal-level independent variables: (a) sex; (b) college (PS, BS, SS, HM, or US); and (c) college GPA rank (1 = *below 2.00*, 2 = *2.10 – 2.50*, 3 = *2.51 – 3.00*, 4 = *3.01 – 3.50*, or 5 = *above 3.51*). The researchers computed two separate ANOVAs using different interval-level dependent variables. The first set of dependent variables (ANOVA1) was a 5-element vector composed of average GPAs for the five categories of high school courses each participant completed (English, math, science, history, and foreign language). The second set (ANOVA2), also arranged in a 5-element vector, was the number of courses taken by each participant in the five categories of high school courses considered.

ANOVA1 revealed a statistically significant ($p < .0001$) relationship between high school grades and both sex and college GPA rank. Females earned higher grades in high school English, history, and foreign language courses. High school grades were significantly positively related to college GPA rank at the .001 level. ANOVA2 indicated a significant relationship between the number of high school courses taken per category with sex and college. Males completed more high school math and science courses. Females completed more foreign language courses. Students with greater numbers of math and science courses in high school were significantly more likely to select a college major in that field.

An interaction effect for ANOVA2, sex by college, was significant. Discriminant function analysis, using high school courses as dependent variables, revealed two discriminant functions. Based on the discriminant functions and a plot of the centroids of the ten sex by college cells in two-dimensional discriminant space, Sexton and Goldman (1975) concluded males were more predictable in their college major selection. Females displayed wider variability and less predictability in their high school preparation patterns in relation to college major selected.

Kirchner (1993) explored the relationship among gender, undergraduate grade point average (GPA), and scores on the Graduate Record Examination (GRE) and academic success in graduate work. The researcher's focus was examining gender's role as a moderator variable. Study participants were students ($N = 103$; 80 females and 23 males) pursuing Master of Arts in Teaching degrees at a small, private, liberal arts institution during the two school years between 1990 and 1992.

Four predictors, grouped together as interval-level academic variables, were: (a) undergraduate GPA, (b) GRE verbal, (c) GRE quantitative, and (d) GRE analytical. The fifth predictor, the variable of interest to Kirchner, was gender. The dependent variable was graduate GPA.

Gender entered the hierarchical multiple regression first, followed by the set of four academic variables. A set of interaction effects, gender by each of the academic variable, entered last. The only statistically significant increase in R^2 resulted from the academic variables' contribution to the model. Gender, and gender's interaction with the academic variables, made insignificant contributions to the prediction of graduate GPA.

Summary. These studies reported several findings regarding the prediction of female students' cumulative college GPA. High school achievement and aptitude measures were significant contributors to the prediction equation (Houston, 1980; Ancis & Sedlacek, 1997). Additionally, gender differences in courses taken in high school were highly correlated with choices and achievement in college (Sexton & Goldman, 1975). Gender was not associated with academic achievement in graduate courses.

Prediction of Persistence with Gender

Bean and Covert (1973) attempted to discriminate between three categories of college students (persisters, dismissals, and withdrawals) using measures of scholastic aptitude and personality with sex as the independent variable of interest. Persisters stayed in school at least two years after admission. The college required dismissals to leave because of low grades. Withdrawals left voluntarily. The researchers hypothesized that academic aptitude would differentiate between persisters and dismissals, whereas personality measures would differentiate between dismissals and withdrawals. Subjects were full-time freshmen ($N = 2,358$) at a large urban university in the fall of 1964.

The predictor variables, measured at the interval level, were SAT-Mathematics (SAT-M) scores, the SAT-Verbal (SAT-V) scores, and three composite scores from the Runner Studies of Attitude Patterns-College Form. The researchers employed principal component analysis on the ten Runner scales. The three resultant components, accounting for 54% of the variance in the responses, were independence (IND), acquiescence (ACQ), and nonassertiveness (NA).

Bean and Covert (1973) employed discriminate analysis to predict membership in the three criterion groups separately for males and females. Results indicated the predictors

significantly differentiated between the three groups for both males and females. The first discriminate function for both sexes, academic ability, contained the predictors SAT-M and SAT-V. The academic ability function accounted for 89% of the variance for males and 77% of the variance for females. The second discriminate function, significant only for females, centered on high scores for IND and NA, accounting for 23% of variance. Academic aptitude measures discriminated between persisters and dismissals for both sexes. Personality measure discrimination between withdrawals and dismissals was supported only for females.

Bean (1980) tested a causal model of student attrition, adapted from employee turnover models in the private sector, and to rank the variables by their contribution to explaining variance in student attrition. Based upon a review of employee turnover and student attrition literature, Bean hypothesized students leave college for the same reasons employees leave work organizations. Study participants, freshmen ($N = 907$) enrolled in a first year English course at a major midwestern university, completed a 107-item questionnaire in December 1977. The sample included 366 males and 541 females. Participants were single, White, under 22-years-old, and U.S. citizens.

The questionnaire yielded 28 predictor variables. On scale items, participants responded using a 5-point Likert-type scale (five being more favorable than one). The extremes of the scale were anchored "to a very small extent" and "to a very great extent." Factor analysis produced fifteen variables with coefficient alphas from .60 to .94. These factored variables were development, practical value, integration, goal commitment, communication requirements, communication rules, distributive justice, centralization, advisor, staff/faculty relationships, transfer opportunity, job opportunity, performance,

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satisfaction, and institutional commitment. The remaining 13 variables, measured from single questionnaire items, were routinization, institutional quality, university GPA, campus job, major area, major certainty, housing, campus organizations, home opportunity, socioeconomic status, state resident, home distance, and hometown size. The criterion variable to measure dropout, provided by the university registrar, was enrollment status in the fall of 1978. The researcher utilized multiple regression and path analysis by gender.

For women, the 28 variables accounted for 22% of the variance in dropout. The significant predictors were institutional commitment ($p < .001$), institutional quality ($p < .05$), and routinization ($p < .05$). For men, four variables were statistically significant ($p < .05$) in the model: institutional commitment ($p < .001$), routinization, satisfaction, and communication. R-square was .09.

Bean (1980) conducted path analysis, separately for males and females, using satisfaction, institutional commitment, and dropout as the dependent variables. Results indicated no significant changes to the female dropout regression equation. Dropout prediction for males improved to 12% with the deletion of nonsignificant variables. Bean's results provided support for the comparison of student attrition with employee turnover. Dropout for women was more predictable than for men. Institutional commitment was the most significant predictor for both sexes.

Cambiano, Denny, and De Vore (2000) sought to ascertain whether grade point average (GPA), ACT score, gender, and age were predictors of persistence at a mid-size, public, doctoral university in the central United States. Student persistence is desirable for universities. Besides the obvious benefits to the students, persistence encourages

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stability within the university. The participants were the entering freshmen class ($N =$ 2,499) in the August term of 1989. The sample was 52% male and 48% female. Study data were obtained from application materials and collected each semester for six years.

The predictor variables were: (a) high school GPA, (b) ACT scores, (c) age (19 years of age and younger, 20 years of age and older), and (d) gender. The criterion was enrollment status in one of two categories (on track or off track). On track students graduated or were currently enrolled. Off track students were not currently enrolled in the university and were not graduated.

The researchers employed a series of logistic regressions to assess the impact of each predictor on the criterion during seven points in time (2nd, 3rd, 5th, 7th, 9th, 11th, and 13th semesters) during the six year study. High school GPA added significantly ($p < .01$) to the model at each semester. Students with higher GPAs are more likely to be on track at each semester. ACT score added significant predictive power at each semester, supporting the traditional conception that student with higher ACTs are more likely to be on track. Gender was a significant predictor only at semester 9. Females in the first semester of the fifth year were slightly less likely than males to be on track. Age added predictive power only during semester 2. Older, nontraditional students were less likely to be on track than traditional age students. High school GPA and ACT scores were significant predictors of persistence at each semester. Gender and age added predictive power infrequently.

Summary. The studies addressing gender's influence on persistence produced mixed findings. Bean and Covert (1973) reported significant differences between men and women in regards to the contribution of attitudinal and personality variables to the

prediction of persistence. Whereas aptitude measures were better discriminators for males, attitudinal data was significant only for females. Bean (1980) confirmed this finding with his causal model of student attrition. The prediction of persistence was more accurate for women than for men. Conversely, Cambiano, Denny, and De Vore (2000) reported a significant contribution from gender only at the ninth semester.

Overall, the literature regarding gender's influence on college performance prediction supports three conclusions. First, women's college grades and persistence are more predictable than men's grades and persistence (Seashore, 1962; Gross, Faggen, & McCarthy, 1974; Bean, 1980; McKelpin, 1965). Second, college preparation differs by gender. Though females earn higher GPAs in high school, males complete more math and science courses in high school as preparation for college-level work (Sexton & Goldman, 1975). Third, race and gender interact to influence predictive validity. The academic performance of Black males holds the lowest correlation to intellective predictors (Sampel & Seymour, 1971; Thomas & Stanley, 1969). As was the case with prediction of college performance by race, gender is a moderating variable for predicting college grades and persistence. Institutions must consider gender or accept the subsequent loss of predictive accuracy. Universal prediction equations, used for both sexes, tend to underpredict the academic performance of one sex and overpredict the academic performance of the other sex (Paraskevopoulos & Robinson, 1970).

Information Supply Chain Management

Supply chain management is a business concept describing the process of collaboration between different firms to leverage strategic positioning and to improve operational efficiencies (Bowersox, Closs, & Cooper, 2002). Supply chain operations

require managerial control across internal organizational boundaries to link with outside partners for coordination and improved operations. Supply chain management is applicable to any industry and any process that includes two or more firms striving collaboratively to maximize their competitive advantages. Information supply chain management refers to this same process but with a focus on the sharing and coordination of information between firms, as opposed to the management of goods, services, and products.

Though not previously addressed in the educational literature, both concepts (supply chain management and information supply chain management) are relevant to the current study. The flow of product (students) between the Jefferson County Public School system and the University of Louisville indicates the magnitude of the relationship. The flow of information between the two systems, however, may not be supporting the realization of each institution's goals, Kentucky's public education goals, or the potential of their combined competitive advantage. The following two subsections address the generalized supply chain model and its relevance to this study.

The Generalized Supply Chain Model

The generalized supply chain model is a cooperative production process involving multiple firms and continuous feedback. A supplier network moves materials to an integrated enterprise. The integrated enterprise converts the materials to finished products and ships to the end consumers through a distributive network. Throughout the process, information, product, services, finances, and knowledge flow between firms to maximize output and profit (Bowersox et al., 2002). Each network, and each firm within

those networks, cooperates and collaborates within the chain to maintain the competitive advantage. Inter-firm cooperation benefits all parties, except the competition.

Kentucky's system of public education can be viewed as a supply chain model. The raw materials are Kentucky students. The desired end product is an educated populace with the skills, abilities, and vision to energize the state's economy. The supplier network refers to Kentucky's system of secondary education. Postsecondary institutions are the integrated producers. The distributive network refers to the companies and agencies hiring and employing Kentucky college graduates. As a microcosm within this larger model, JCPS and U of L form a more intimate supply chain model. Regardless of the size of the model or its scope, the key component for success within an information supply chain is the free and unhindered flow of vital data. The demands on Kentucky public education to achieve positive outcomes and the mission overlap between the secondary and the postsecondary education systems support information supply chain management as a concept critically relevant to the success of Kentucky's public education systems.

Relevance to this Study

In their 1999 book, *Quick Response*, Lowson, King, and Hunter described the rapid growth of consumerism and management's response. Consumerism is the power enjoyed by the purchasing public to demand quality goods and services, variety, choice, and options. The public exercises this power in the business world through buying decisions. Industry is responding to consumerism with supply chain management. Supply chain management, where competently administered, meets the public's demands and maintains a competitive advantage over rival firms.

Kentucky is currently experiencing educational consumerism. The state legislature demanded and mandated a better educational product from its public education institutions with the passage of KERA in 1990 and the Kentucky Postsecondary Education Improvement Act in 1997. Kentucky wants a competitive educational advantage over other states to improve the quality of life in the Commonwealth. Effective information supply chain management, collaboration between Kentucky's secondary and postsecondary institutions in regards to the flow of students and information, is a critical step toward achieving that goal.

In addition to the requirements levied by state government, public education is also under attack from private industry. Lowson et al. (1999) further described the pressures domestic firms are under from low-priced imports in the marketplace. Supply chain management is a part of the answer these domestic firms need to regain market share and a competitive edge. Similarly, public education is experiencing competition for students and funding.

The pressures which forced private industry to leverage the information supply chain in the 1980s and 1990s are similar to the challenges faced by Kentucky's public education systems: (a) budgetary crises, (b) lack of planning, (c) excess capacity, (d) poor quality, and (e) ineffective management information systems (Powell, 2001). Proprietary schools, internet colleges, charter schools, and other nontraditional education institutions are the competitors to public education's marketplace dominance. Without careful resource, information, and product management, public education could lose its position in the educational marketplace. Supply chain management, especially between two institutions as strongly linked as JCPS and U of L, is a critical piece of the solution.

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Finally, as institutions downsize to focus on core processes and outsource secondary functions, supply chain management grows in importance (Magretta, 2000). The University of Louisville has consolidated its operations in recent years. Most notably, U of L now relies upon Jefferson Community College (JCC) for developmental studies. The flow of information and product between U of L and JCC (supply chain management) is critical to the success of that relationship. Though supply chain management has not previously been considered in an educational context, it is clearly relevant to this research and the relationship between U of L and JCPS in the education supply chain.

Overall Summary

The prediction of college success encompasses a variety of variables, criteria, methods, and statistical analyses. The predictor variables include: (a) intellective measures, such as SAT scores, ACT scores, and high school GPA and rank in class (Gordon, 1974; Lavin, 1965; Baron & Norman, 1992); (b) nonintellective measures, such as demographic and environmental variables (Wright & Bean, 1974; Ting & Robinson, 1998); and (c) noncognitive variables, such as attitudinal and opinion variables (Tracey & Sedlacek, 1984; Gordon, 1989). Race and sex, in addition to containing strong predictive utility, significantly influenced and moderated the effect of other predictor variables (Stanley & Porter, 1967; Paraskevopoulos & Robinson, 1970).

The criteria for college success studies included semester GPA (Klugh & Bierly, 1959), cumulative GPA (Baron & Norman, 1992), persistence (Tinto, 1975), and graduation (Clarkson & Roscoe, 1993). The focus was frequently on first semester GPA or freshman year GPA because of the nature of college student retention rates. As the

highest attrition rate occurs between the freshman and sophomore years (Pantages &

Creedon, 1978), institutions and researchers focus on this critical time period.

Research designs included cross-sectional and longitudinal studies. Cross-sectional

designs permit a one-time glimpse at variables and criteria (Hills, 1964; Norton-Welsh &

Reding, 1992). Any consideration of past events or prior variable influence relies on

participant recall or institutional record-keeping. Longitudinal studies provide valuable

information on the shifting importance and impact of variables on the criteria over time

(Lavin, 1965; Pascarella & Terenzini, 1980).

Statistical analyses included correlations, analysis of variance, multiple regression,

logistic regression, and discriminant analysis. Correlational analysis provides quick

impressions of the magnitude of the relationship between a predictor and a criterion.

Frequently, correlational analysis provides the starting point for more complex analyses

(Sedlacek & Adams-Gaston, 1992) or future studies. Analysis of variance (ANOVA) is

rarely used in this field of study. ANOVA is useful for comparing students by major

(Fletcher, Halpin, & Halpin, 1999), minority status (Eimers, 2001), or sex (Sexton &

Goldman, 1975).

Multiple regression is the predominant statistical technique for predicting college

GPA. All variables must be measured on at least the interval level, or dummy coded

(Stevens, 1996). Most intellective measures and Likert-scaled variables meet this

requirement. Multiple regression is well-suited for simple analyses determining the

variance accounted for in GPA by a few variables (Fincher, 1974; Chase & Jacobs, 1989)

or more complex analyses with multiple predictors and control variables (Young &

Sowa, 1992; Lewallen, 1993).

Discriminant analysis and logistic regression are the predominant statistical techniques for predicting persistence and graduation status. As data used in a discriminant analysis must conform to the requirements of the general linear model (normality, independence, and homogeneity of variance), logistic regression can be used when the data do not meet those requirements (Stevens, 1996). Researchers used discriminant analysis to classify students as persisters, dropouts, or stopouts at specific points in their college careers (Pascarella, Duby, Miller, & Rasher, 1981; Boyer & Sedlacek, 1988). Correct classification, particularly the correct classification of dropouts before the dropout occurs, is useful information for university officials. With prior warning, student service personnel can implement programs and interventions to maximize retention and minimize attrition (Pascarella & Terenzini, 1980). Logistic regression allows researchers in this field to calculate the odds of a student persisting (Levin & Wyckoff, 1995; Hall & Gahn, 1994) or graduating. The benefits are the same as for discriminant analysis.

The success of postsecondary institutions is linked directly to the success of students (Levitz, Noel, & Richter, 1999). University officials have a responsibility to explore and understand the variables that impact the success, persistence, and graduation of students from all backgrounds, races, and circumstances (Baker & Velez, 1996). The tools and resources are available for any institution to fulfill that responsibility and maximize the opportunity for the success of its students.

Advancements

The existing body of research on the prediction of college academic performance included variable measures in the following areas: (a) performance, (b) aptitude, (d) demographics, (d) noncognitive, (e) gender, (f) race, and (g) accession source. Though

high school performance predictors dominate regression equations, few studies probed deeply into that resource for additional sources of grade variance accountability. No studies considered the performance of a student population from one entire school district. No studies investigated the relationship of Kentucky high school graduates' Commonwealth Accountability Testing System (CATS) scores' relationship to college performance and persistence.

The present investigation proposes two advancements. First, data analysis will include all students from the 26th largest school district in the country, the Jefferson County Public School (JCPS) system, who attend one university, the University of Louisville (U of L). Second, CATS scores for JCPS graduates at U of L will be assessed for utility and validity as predictors of college GPA and persistence.

CHAPTER III

METHODOLOGY

The purpose of this research was to investigate variables for predictive power in regards to college student academic performance and persistence. The covariates were consistent predictors of college student academic performance and persistence in the literature reviewed in Chapter II. This study's focus was on the predictive potential of variables specific to Kentucky (CATS scores) and Jefferson County Public Schools (college preparation coursework) beyond the contribution of the established covariate predictors. The literature reviewed in Chapter II supported the selection of dependent variables (criteria), covariates, and independent variables of interest (predictors). This chapter addresses the methodology selected to address the three research questions listed in Chapter I.

Theoretical Framework

Burnham and Hewitt (1972) and Ansley and Forsyth (1983) provided the theoretical framework for the present study. Burnham and Hewitt's goal was to explore the secondary school record, beyond high school GPA, for significant predictors of first year college GPA. Their focus was on the predictive power of types of high school grades: letter grades versus numerical grades. For consistency and study validity, each participant completed the final three years of their secondary education at one institution. The current study drew upon Burnham and Hewitt's research, paralleling their

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investigation for additional sources of variance within the high school record. In addition, study participants must have attended Jefferson County Public Schools for the final three years of their secondary education and completed required CATS testing appropriate for the 10th, 11th, and 12th grades.

Ansley and Forsyth (1983) tested the predictive validity of Iowa Test of Educational Development (ITED) scores from high school on college GPA. Ansley and Forsyth compared ITED score correlations with college performance measures to the results obtained from ACT scores and high school GPA. Their study restricted its focus to Iowa high school graduates' performance at the University of Iowa. The current study drew upon the work of Ansley and Forsyth by focusing on high school test scores unique to Kentucky (CATS scores) and on student performance and persistence at one state university. The design of this investigation builds upon this theoretical framework.

Research Design

This research followed a correlational design using secondary archival data from JCPS and U of L (Shavelson, 1996). An experimental design, characterized by random selection, random assignment, experimenter manipulation, and experimenter control, can provide some inferences regarding cause and effect. This study's nonexperimental design lacks randomization or variable manipulation (Keppel & Zedeck, 2000). Covariates provide a measure of control over background characteristics (e.g., sex, race, and socioeconomic status) and conventional achievement and ability measures (high school GPA and ACT score). Though a correlational research design provides weak evidence regarding a causal relationship between the variables (Campbell & Stanley, 1963), the results can be interpreted for associative impact (Keppel & Zedeck, 2000).

The selection of a correlational design, as for this study, was appropriate when the manipulation of independent variables raises moral and ethical issues (Miller, 1991). In regards to the current study, manipulating any of the variables of interest was morally unacceptable or unnecessary. CATS test scores required no experimenter manipulation. The manipulation of student enrollment in college preparatory courses was unethical because of the long-range implications to the participant's future academic career. A correlational design using secondary data for multiple regression and discriminant analysis procedures addressed each of these issues while focusing on the research questions.

Stevens (1996) listed the following three considerations before selecting a regression model: (a) testing the assumptions for the linear regression model, (b) estimating the cross validity power of the equation, and (c) checking for outliers and influential data points. These three issues advised the current study's research design. Both linear regression and discriminant analysis are part of the general linear model (GLM). GLM procedures assume that errors are independent (independence) and follow a normal distribution (normality) of constant variance (homogeneity of variance) (Stevens, 1996). This third assumption, when referring to multiple regression, becomes an assumption of homoscedasticity (Cohen, 1988). An assessment of the procedures used to measure or record the secondary data verifies its independence. An inspection of the histograms of the standardized residual for each dependent variable verifies normality. A check of the graph for standardized residuals versus predicted values verifies homoscedasticity (Stevens, 1996).

The current study's research design addressed Stevens' (1996) second consideration for regression model selection, cross validation power, by including Stein's adjusted R^2, a conservative estimate of the derived equation's predictive power on other samples from the same population. R^2, the proportion of variance accounted for in the criterion by the predictor variables, provides the practical significance of the prediction equation.

Stevens' (1996) third consideration for regression model selection related to outliers and influential data points. Outliers can occur in both the predictor variables and the criterion variable. A check of the standardized residuals plot for the criterion variable identifies outliers (points above 3.0). A check within the predictor variables, using $3p/n$ as a cutoff ($p = k + 1$, $k =$ number of predictors, $n =$ number of participants) on the centered leverage values, identifies predictor outliers. A Cook's distance value greater than one identifies an influential data point. The protocol for handling outliers or influential data points starts with verifying the raw data's accuracy and, lacking resolution, could require data transformation or deletion.

Participants and Sampling

The participants in this research investigation completed the final three years of their secondary education in the Jefferson County Public School system, graduated in 2001 from a JCPS high school, and subsequently enrolled at the University of Louisville in the fall of 2001 as freshmen. The JCPS high schools included in this investigation were: (a) Atherton, (b) Ballard, (c) Brown School, (d) Butler Traditional, (e) Central, (f) Doss, (g) duPont Manual, (h) Eastern, (i) Fairdale, (j) Fern Creek Traditional, (k) Iroquois, (l) Jeffersontown, (m) Louisville Male, (n) Moore Traditional, (o) Pleasure Ridge Park, (p) Seneca, (q) Shawnee, (r) Southern, (s) Valley, (t) Waggener Traditional, and (u) Western.

The Jefferson County Public School system provides numerous education alternatives for students with specific needs or in unique circumstances. The 21 high schools listed above are the mainstream secondary education providers in the JCPS system, those not otherwise described by JCPS as 'special schools'. This study's focus was on these 21 mainstream high schools. The requirements for inclusion in this sample were that a student: (a) graduated from a JCPS high school in 2001, (b) attended a JCPS high school for the final three years of secondary education, and (c) attended U of L as a first year student beginning in the fall of 2001.

The minimum sample size for this investigation was 380. There were 5 control variables and 10 independent variables of interest. After dummy-coding for sex, race, socioeconomic status, and college preparatory curriculum completion, there were 19 predictors (k) entering the equations. Based upon the multiple regression sample size tables developed by Park and Dudycha in 1974 for 15 predictors (cited in Stevens, 1996), 214 participants produce a 14.3 to 1 ratio (n to k) of subjects to predictors with a conservative estimate of R^2 equal to .50 for effect size, significance at .05, and power at .80. Interpolating for the four additional variables, this study's multiple regression analyses required a minimum sample size of 271.

A second approach proposed by Green (cited in Tabachnick & Fidell, 2001), assuming a medium effect size ($f^2 = .15$) consistent with the literature, directed a sample size greater than or equal to 50 + (8) (number of predictors) if testing the equation's multiple correlation. Using this formula, the minimum sample size for this study's multiple regression analyses was 202. For a discriminant analysis, Stevens (1996), recommended a 20-to-1 ratio of cases to predictors for confidence in the cross-validation validity of the

discriminant function to another sample from the same population. The minimum sample size for the discriminant analysis was 380. Taking the larger of these three values, the minimum sample size for this study was 380.

All eligible 2001 JCPS graduates enrolled at U of L in the fall of 2001 were included in this study. Because over 62% of U of L's first-time freshmen in the fall of 2001 were Jefferson County residents, the final sample size, 694, substantially exceeded the minimum requirement. Maintaining or increasing this *n/k* ratio is critical for maximizing the generalizability and cross-validating properties of the prediction and discriminant analysis equations (Stevens, 1996).

Independent Variables

The independent variables of interest included six CATS scores for each participant (reading, science, mathematics, social studies, writing on demand, and writing portfolio), completion of the ACT college preparatory curriculum (three levels: not met, met, and exceeded), and completion (yes, no) of the following three higher-level math courses: (a) pre-calculus, (b) calculus, and (c) college preparatory algebra. The four categorical variables describing college preparation were dummy-coded for inclusion in the statistical calculations. This procedure was appropriate for the inferential statistics used in the study.

JCPS reported CATS scores on two scales. The reading, mathematics, science, and social studies CATS scores were ordinal variables with eight levels (no attempt, medium novice, high novice, low apprentice, medium apprentice, high apprentice, proficient, and distinguished). The relationship between the variables levels, building from 'no attempt' to 'distinguished', allowed for a conversion to scale scores ranging from one to eight (1 =

lowest, 8 = highest). The two writing scores, writing-on-demand and writing portfolio, were ordinal variables with four levels (novice, apprentice, proficient, and distinguished). The relationship between the four levels, building from 'novice' to 'distinguished', allowed for a conversion to scale scores ranging from one to four (1= lowest, 4 = highest).

The operational definitions for these variables follow below. Each CATS test, excluding the writing scores, included multiple-choice and open response questions. A student's CATS test score was based upon a weighted formula. Multiple-choice questions, with a range of 0 (incorrect) to 1 (correct) point, counted one-third toward the final score. Open response questions, with a range of 0 to 4 (0 = incorrect/irrelevant, 1 = minimal information, 2 = limited information, 3 = complete with flaws, 4 = complete without errors), counted two-thirds toward the final score.

1. CATS reading score – participant score on the CATS reading test, consisting of 24 multiple choice questions and 6 open response questions, completed during 10th grade; JCPS maintained and reported the score (ordinal-level variable with eight levels converted to integers from 1 to 8).

2. CATS science score – participant score on the CATS science test, consisting of 24 multiple choice questions and 6 open response questions, completed during 11th grade; JCPS maintained and reported the score (ordinal-level variable with eight levels converted to integers from 1 to 8).

3. CATS mathematics score – participant score on the CATS mathematics test, consisting of 24 multiple choice questions and 6 open response questions,

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completed during 11th grade; JCPS maintained and reported the score (ordinal-level variable with eight levels converted to integers from 1 to 8).

4. CATS social sciences score – participant score on the CATS social studies test, consisting of 24 multiple choice questions and 6 open response questions, completed during 11th grade; JCPS maintained and reported the score (ordinal-level variable with eight levels converted to integers from 1 to 8).

5. CATS writing-on-demand score – participant score on the CATS writing-on-demand test completed during 12th grade; JCPS maintained and reported the score (ordinal-level variable with four levels converted to integers from 1 to 4).

6. CATS writing portfolio score – participant score on the CATS writing portfolio requirement for 12th grade; JCPS maintained and reported the score (ordinal-level variable with four levels converted to integers from 1 to 4).

7. Completion of college preparatory curriculum – participant completion of four English courses, three math courses at or above the level of algebra and geometry, three natural science courses, and three social science courses; three levels (not met, met, exceeded) dummy-coded for inclusion in multiple regression and discriminant analysis; JCPS maintained course information and student transcripts (categorical variable with three levels dummy-coded into two dichotomous variables).

8. Completion of pre-calculus in high school – participant completion of one year of pre-calculus in high school; two levels (no = 0, yes =1) dummy-coded for inclusion in multiple regression and discriminant analysis; JCPS maintained

course information and student transcripts (categorical variable with two levels dummy-coded as one dichotomous variable).

9. Completion of calculus in high school – participant completion of one year of calculus in high school; two levels (no = 0, yes =1) dummy-coded for inclusion in multiple regression and discriminant analysis; JCPS maintained course information and student transcripts (categorical variable with two levels dummy-coded as one dichotomous variable).

10. Completion of college preparatory algebra in high school – participant completion of one year of college preparatory algebra in high school; two levels (no = 0, yes = 1) dummy-coded for inclusion in multiple regression and discriminant analysis; JCPS maintained course information and student transcripts (categorical variable with two levels dummy-coded as one dichotomous variable).

Control Variables

The control variables included sex, race, ACT-Composite score, high school GPA, and socioeconomic status. High school GPA and ACT-Composite score are interval-level measures. Sex (female, male), race (Asian, Black, White, and Other), and socioeconomic status (low, medium, and high) were categorical variables dummy-coded for use as predictors. The operational definitions for these variables are as follows:

1. Sex – sex of the participant (0 = female, 1 = male) as recorded by the University of Louisville from the participant's undergraduate application for admission (categorical variable with two levels dummy-coded as one dichotomous variable).

2. Race – race of the participant (Asian, Black, White, and Other) as recorded by the University of Louisville from the participant's undergraduate application for

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admission; the category 'Other' included American Indian/Alaskan Natives, Hispanics, and one Not Applicable (categorical variable with four levels dummy-coded into three dichotomous variables).

3. Socioeconomic status – socioeconomic status (SES) of the participant as defined by free or reduced lunch eligibility (free, reduced, and full pay), determined in accordance with federal guidelines by the Jefferson County Public School system and recorded in participant's school record; eligibility for free lunch was low SES; eligibility for reduced lunch was medium SES; noneligibility for free or reduced lunch was high SES (categorical variable with three levels dummy-coded into two dichotomous variables).

4. High school GPA – participant's cumulative grade point average from high school as recorded by the Jefferson County Public School system (interval level measure).

5. ACT-Composite score – participant's American College Testing (ACT) Composite score, as recorded by the University of Louisville in the participant's college record (interval level measure).

Dependent Variables

The dependent variables were first semester college GPA, first year college GPA, and persistence (retention status) in the fall semester following the freshman year. The GPA dependent variables were interval-level variables and suited for use as criterion measures in multiple regression analyses. Persistence (yes, no) was a nominal-level variable and appropriate for use as a criterion measure in a discriminant analysis.

This study excluded participants from the fall 2001 first semester college GPA regression if the student withdrew from all fall courses prior to grade submission. This study excluded participants from the spring 2002 first year college GPA regression if the student withdrew from all spring courses prior to grade submission. This study also excluded participants enrolled in all developmental courses in a given semester, fall or spring, from that semester's regression calculation. The college record reflected a 0.00 GPA for students who withdrew from all courses or who were enrolled in all developmental courses. This 0.00 GPA does not affect the cumulative college GPA of the student, however, and reflected a lack of data as opposed to a lack of performance in the course of study. The operational definitions for the criterion variables of this study are as follows:

1. First semester college GPA – participant's cumulative grade point average, based on a 4.0 scale, after one semester in college (fall 2001) as recorded by the University of Louisville (interval level measure).

2. First year college GPA – participant's cumulative grade point average, based on a 4.0 scale, following completion of the freshman year (spring 2002) as recorded by the University of Louisville (interval level measure).

3. Persistence – participant's retention status at the University of Louisville at the beginning of the fall semester (fall 2002) of the sophomore year (0 = non persister, 1 = persister); persisters included students enrolled full-time, half-time, or with any course load in fall 2002 at the University of Louisville (categorical variable with two levels dummy-coded as one dichotomous variable).

Data Analysis

This study used archival data from the Jefferson County Public School system and the University of Louisville. Data collection involved queries from their respective databases and records. Participant social security numbers, maintained by both institutions, were the keys to matching data from the two systems.

The data analysis for the present study included descriptive and inferential statistics. SPSS 10 was the statistical package used for all procedures. All variables (sex, race, ACT score, high school GPA, socioeconomic status, six student CATS scores, four college preparatory course variables, first semester college GPA, first year college GPA, and persistence status) produced descriptive statistics. The inferential statistics include results from hierarchical least squares multiple regression and hierarchical discriminant analysis. Hierarchical multiple regression addressed the first two research questions from Chapter I regarding the prediction of college GPA at two points. Discriminant analysis addressed the third research question from Chapter I regarding the discrimination of group membership (persister, non-persister) after one year of college. Splitting the sample into calibration and cross-validation groups is inappropriate for this study due to the hierarchical method of variable entry (Tabachnick & Fidell, 2001).

Multiple Regression

Multiple regression presents numerous models for selecting a set of predictors, such as hierarchical, forward, stepwise, and backward selection procedures (Stevens, 1996). Hierarchical multiple regression, with the covariates first entering the equation setwise, best suited this study's requirements based on the substantive knowledge derived from the review of the literature. The benefits of this approach, judiciously selecting

predictors and applying substantive knowledge to their use in the regression, are maintaining scientific parsimony, increasing the n/k ratio, and improving cross-validation prospects (Stevens, 1996). Cohen and Cohen (1975) labeled this rationale for variable ordering as research relevance.

The current study employed two multiple regressions, one for each college academic performance criterion: first semester GPA and first year GPA. Research relevance, based upon the covariates' predictive potential established by the literature, dictated the covariates enter the regression first setwise (Step 1). The variables of interest entered next. The six CATS scores entered setwise (Step 2) followed by the college preparation variables (Step 3).

The statistics of interest for the two multiple regression equations, one each for first semester college GPA and first year college GPA, are R^2 and R^2 *Change*. Specifically, is the change in R^2 significant when the variables of interest are added to the equation after the covariates? If the change in R^2 is statistically significant, the variables of interest significantly improved the regression equation's ability to predict college GPA.

Discriminant Analysis

The selection of a discriminant analysis procedure followed closely the justifications for hierarchical multiple regression. Discriminant analysis adheres closely to the statistical path established by multiple regression, but uses canonical correlations to predict memberships in a group based on a categorical criterion variable. As with the multiple regressions, research relevance dictated the covariates enter the regression first setwise (Step 1). The variables of interest entered next. The six CATS scores entered setwise (Step 2) followed by the college preparation variables (Step 3).

A discriminant analysis produces numerous statistics of interest. First, the significance of change in canonical correlation coefficient squared after the predictors of interest enter the equation is an indication of the proportion of variance accounted for by those variables in the prediction of group membership. The F statistic, calculated using the Wilk's Λ generated at each step of the hierarchical discriminant analysis, provides a measure of significant improvement in classification (Tabachnick & Fidell, 2001). Though persister and non-persister groups will have unequal sizes, prior probabilities will be set at .50 for both groups to maximize correct classifications of non-persisters.

This decision produces a conservative estimate of overall correct classifications (Pascarella & Terenzini, 1980). Additionally, all covariates and predictors were forced into the discriminant analysis to maximize interpretability of each variable's contribution to the discriminant function and minimize interpretation problems regarding dummy-coded predictors representing categorical variables with more than two levels: race, socioeconomic status, and college preparation curriculum completion (Pedhazur, 1997).

Study Limitations

This study had three limitations. The first limitation related to geography. This investigation's focus rested squarely on the relationship between the Jefferson County Public School system and the University of Louisville. With respect to the cultural and societal background of Louisville, KY, this sample was homogenous. Generalizability beyond this population is cautioned.

The second limitation of this study is related to the choice of variables. The use of CATS scores limited the generalizability of this research to the state of Kentucky. Additionally, the range of the CATS scores (one to eight for reading, math, science, and

social sciences; one to four for writing-on-demand and writing portfolio) was limited. This restricted variability potentially restricted the predictive power of the variable (Cohen & Cohen, 1975).

The third limitation of this study was the use of secondary data. Secondary data are information not specifically gathered for the research question at hand (Stewart, 1984). The use of secondary information in a research study, or secondary analysis, has advantages and drawbacks.

The advantages of using secondary data are savings in time and money. It is cheaper and faster to use data already available than collecting that information with research instruments. When data are already gathered and stored, additional data collection using surveys or research instruments introduces unnecessary error into the study.

There are disadvantages associated with secondary data. The disadvantages of secondary data include deliberate or unintentional bias and errors related to aggregation, category definitions, measures, and timeliness (Stewart, 1984). Unintentional bias can occur when data are gathered for a purpose other than that intended for the study. Intentional bias can occur when data sets are purposely altered or corrupted to achieve a desired objective. Information is lost when data are combined, summarized, or otherwise aggregated. Categories and levels of measurement may not work within the framework of the investigation. Finally, secondary data are old data. Access to the original data and an understanding of its generation and collection, as is the case in this research, minimizes the disadvantages of using secondary data (Church, 2002).

CHAPTER IV

RESULTS

This study explored the predictive potential of Commonwealth Accountability Testing

System (CATS) scores and college preparatory course completion on college academic

performance and persistence for Jefferson County Public School (JCPS) system graduates

at the University of Louisville (U of L). The three research hypotheses focused on these

variables' predictive power on the criterion variables beyond the predictive contribution

of five control variables. This chapter reports the findings related to this investigation in

four sections: (a) descriptive statistics, (b) results of regression on first semester GPA,

(c) results of regression on first year GPA, and (d) results of discriminant analysis on

persistence to sophomore year.

Descriptive Statistics

The researcher followed the data collection procedure outlined in Chapter III. The

University of Louisville provided data for all 2001 JCPS graduates from designated high

schools enrolled at U of L as first-time freshmen in the fall of 2001. JCPS provided the

remaining data for that identified student population. A total of 694 participants met all

requirements for inclusion in the study.

Table 1 shows the descriptive statistics for the participants. Number (N) and

percentage (%) describe categorical variables. The range, mean, and standard deviation

(SD) describe interval-level variables. An overview of the control variables revealed the

Table 1

Descriptive Statistics for Study Participants

Variable	*N*	%	Range	Mean	*SD*
Control Variables					
Gender					
Female	375	54.0			
Male	319	46.0			
Race					
Asian	20	2.9			
Black	128	18.4			
White	535	77.1			
Other	11	1.6			
Socioeconomic Status					
High	601	86.6			
Medium	30	4.3			
Low	63	9.1			
ACT Score	694		14-35	22.32	3.96
High School GPA	693		1.77-4.00	3.24	.48
Predictors					
CATS Scores					
Math	690		1-8	6.70	1.36
Reading	690		1-8	6.39	1.00
Science	690		1-8	6.02	.98
Social Sciences	690		1-8	6.40	1.20
Writing-on-Demand	689		1-4	2.17	.50
Writing Portfolio	691		1-4	2.47	.63

Table 1 (continued)

Descriptive Statistics for Study Participants

Variable	N	%	Range	Mean	SD
College Prep Curriculum Completion					
Exceeded	558	80.4			
Met	39	5.6			
Not Met	97	14.0			
College Prep Algebra in H.S.					
Yes	38	5.5			
No	656	94.5			
Pre-Calculus in H.S.					
Yes	448	64.6			
No	246	35.4			
Calculus in H.S.					
Yes	161	23.2			
No	533	76.8			
Criterion Variables					
First Semester GPA (Fall 2001)	674		0.00-4.00	2.54	1.05
First Year GPA (Spring 2002)	610		0.00-4.00	2.57	.88
Persistence to Sophomore Year	694				
Yes	536	77.2			
No	158	22.8			

Note. $N = 694$.

study participants were mostly female (54%), White (77.1%), and of high socioeconomic status (86.6%). The average of participant ACT scores was 22.32. The average ACT score for 2001 graduating seniors was 20.1 in Kentucky and 21.0 nationally (Kentucky Council on Postsecondary Education, 2002b). The average high school GPA was 3.24.

The variables of interest included six CATS scores and college preparation measures. CATS math, reading, science, and social sciences, measured on an 8-point scale, averaged between 6.02 and 6.70. The two writing CATS scores, writing-on-demand and writing portfolio, averaged 2.17 and 2.47 respectively. Most participants exceeded the ACT college preparatory curriculum (80.4%) and completed high school pre-calculus (64.6%). A minority completed calculus (23.2%) or college preparatory algebra (5.5%).

The criterion variables were two college GPA measures and persistence to the sophomore year. First semester GPA ($M = 2.54$, $SD = 1.05$) and first year GPA ($M = 2.57$, $SD = .88$) were similar, yet the standard deviations revealed greater variability in first semester grades. More than three out of four participants (77.2%) continued their studies at the University of Louisville into the sophomore year.

General Linear Model Requirements

Multiple regression and discriminant analysis are part of the general linear model (GLM). Requirements associated with the GLM, and those assumptions specific to each procedure, include the following: (a) ratio of cases to predictors, (b) normality, linearity, and homoscedasticity of residuals, and (c) consideration of outliers.

Ratio of Cases to Predictors

The ratio of study participants to predictors is substantially above the minimum requirement. The minimum sample size for this investigation was 380. The actual

sample size was 694. Interpolation with 19 predictors using the multiple regression

sample size tables developed by Park and Dudycha in 1974 (cited in Stevens, 1996)

required a minimum sample size of 271 participants. A second approach endorsed by

Green (cited in Tabachnick & Fidell, 2001), using the equation $N \geq 50 + (8)$ (number of

predictors), required a minimum sample size of 202. The first semester college GPA

regression included 660 cases. The first year college GPA regression included 599 cases.

The discriminant analysis, based on Stevens' (1996) recommended 20-to-1 ratio of cases

to predictors, required a minimum of 380 cases. The discriminant analysis included 680

cases.

Normality, Linearity, and Homoscedasticity of Residuals

Each regression produced evidence to support the normality assumption with a

histogram and a scatterplot of the regression standardized residuals. The standardized

residual histograms approximated the bell-shaped normal curve. Scatterplots provided

further evidence of normality with plotted points approximating the diagonal line. The

scatterplot of standardized predicted values and studentized residuals for both regressions

supported the assumptions of linearity and homoscedasticity (Tabachnick & Fidell,

2001). The plotted points were generally scattered randomly above and below the

horizontal line drawn at the zero point of the vertical axis which represented studentized

residual values.

Consideration of Outliers

A visual inspection of the covariates, predictors, and criterion variables, case by case,

verified no outliers or influential data points existed due to recording or transposition

errors. Influential data points have a value on Cook's distance greater than one and

represent cases that could be outliers because their deletion markedly changes regression coefficients (Tabachnick & Fidell, 2001). Neither regression contained an influential data point as identified by a Cook's distance greater than 1.0.

Outliers on the set of predicted values for the criterion variable are standardized residuals > 3.0 or < –3.0. A standardized residual meeting this criterion highlights a case where the actual and predicted values of the criterion were greater than three standard deviations apart. The first semester GPA regression produced five outliers. The first year GPA regression produced four outliers. The actual GPA was lower than the predicted GPA in these nine cases. On the basis of the normal curve distribution, it was expected that .0026 of residuals would exceed $|3.0|$. In this study, the numbers exceeding the criterion were not large.

Regression on First Semester College GPA (Hypothesis 1)

The same set of covariates and predictor variables were regressed separately on first semester college GPA (fall 2001) and first year college GPA (spring 2002). Listwise deletion for the two regressions produced different sample sizes for each criterion. Each regression produced a unique intercorrelation matrix.

Table 2 shows Pearson product-moment correlation coefficients, r, for the criterion variable, first semester college GPA, and selected covariates and predictors. Table 2 does not include categorical covariates and predictors with more than two levels, represented in the regression by dummy-coded variables (Pedhazur, 1997). Ninety percent of the correlations between the criterion and the predictors and the intercorrelations among predictors were significant at the .01 level. Substantial correlation among predictors indicates multicollinearity, which complicates interpretation (Cohen & Cohen, 1975).

Table 2

Intercorrelations for Selected Variables for First Semester GPA Regression

Variable	1	2	3	4	5	6	7
1. Fall 2001 GPA	- -						
2. Sex	-.169**	- -					
3. High School GPA	.395**	-.183**	- -				
4. ACT Score	.123**	.170**	.243**	- -			
5. CATS Math Score	.105**	.198**	.137**	.582**	- -		
6. CATS Reading Score	.145**	-.137**	.194**	.450**	.439**	- -	
7. CATS Science Score	.097**	.215**	.114**	.533**	.655**	.461**	- -
8. CATS Social Science Score	.154**	.106**	.174**	.472**	.600**	.510**	.695**
9. CATS Writing Portfolio Score	.220**	-.139**	.276**	.397**	.247**	.320**	.272**
10. CATS Writing-on-Demand Score	.161**	-.123**	.209**	.223**	.166**	.221**	.149**
11. High School College Prep Algebra	-.069*	.012	-.150**	-.098**	-.036	-.045	-.007
12. High School Pre-Calculus	.100**	.129**	.205**	.321**	.319**	.180**	.226**
13. High School Calculus	.063	.158**	.237**	.388**	.288**	.133**	.174**

**$p<.01$, *$p<.05$.

Table 2 (continued)

Intercorrelations for Selected Variables for First Semester GPA Regression

Variable	8	9	10	11	12	13
1. Fall 2001 GPA						
2. Sex						
3. High School GPA						
4. ACT Score						
5. CATS Math Score						
6. CATS Reading Score						
7. CATS Science Score						
8. CATS Social Science Score	- -					
9. CATS Writing Portfolio Score	.293**	- -				
10. CATS Writing-on-Demand Score	.210**	.202**	- -			
11. High School College Prep Algebra	-.009	-.019	-.068*	- -		
12. High School Pre-Calculus	.211**	.119**	.108**	-.285**	- -	
13. High School Calculus	.095**	.146**	.119**	-.134**	.408**	- -

**p<.01, *p<.05.

The predictors with the highest correlations with first semester college GPA were high school GPA ($r = .395$) and CATS writing portfolio score ($r = .220$). The weakest correlation to the criterion variable was completion of calculus (no = 0, yes = 1) in high school ($r = .063$). Each CATS score was significantly intercorrelated with other CATS scores. The completion of college preparatory algebra in high school (no = 0, yes = 1) produced the fewest significant intercorrelations. The exceptions were negative relationships between college prep algebra and high school GPA ($r = -.150$), ACT score ($r = -.098$), high school pre-calculus ($r = -.285$), and high school calculus ($r = -.134$).

Table 3 displays the results of the hierarchical multiple regression analysis with first semester college GPA as the criterion. The table includes the unstandardized regression coefficients (B) at each step of the regression, the standard errors of regression coefficients (SEB) for the final model (Step 3), and the standardized regression coefficients (β) for the final model. The table also shows the proportion of variance in the criterion accounted for at each step in the regression (R^2) and the change in R^2 at that step (ΔR^2).

All covariates entered the regression at Step 1. The R^2 at this step was significant ($p < .01$) at .185. The addition of CATS scores at step 2 ($\Delta R^2 = .014$) made a statistically insignificant contribution to R^2. College preparation predictors, added at step 3 ($\Delta R^2 = .001$), also made a statistically insignificant contribution to R^2. The unadjusted R^2 for the final model was .201, significant at the .01 level. Wherry adjusted R^2 was .177. The Stein adjusted R^2, a measure of the regression equation's predictive validity on a different sample from the same population, was .152. Stevens (1996) suggested that Stein adjusted

Table 3

Summary of Hierarchical Regression Analysis with First Semester GPA Criterion

Variable	B Step 1	B Step 2	B Step 3	SEB Step 3	β Step 3	R^2	ΔR^2
Step 1: Covariates						.185**	.185**
Sex	-.236	-.200	-.192	.085	-.092*		
Race 1 (White)	-.118	-.216	-.219	.301	-.087		
Race 2 (Black)	-.016	-.107	-.109	.306	-.040		
Race 3 (Asian)	.272	.239	.256	.368	.040		
SES 1 (low)	-.496	-.431	-.434	.156	-.111**		
SES 2 (medium)	-.273	-.245	-.242	.194	-.047		
High School GPA	.789	.730	.736	.087	.338**		
ACT Score	.011	-.012	-.010	.014	-.036		
Step 2: CATS Scores						.199**	.014
Math		.018	.022	.042	.028		
Reading		.014	.015	.050	.014		
Science		.015	.015	.062	.014		
Social Science		.045	.040	.049	.045		
Writing Portfolio		.143	.144	.067	.088*		
Writing-on-Demand		.097	.098	.080	.046		
Step 3: College Prep						.201**	.001
Curriculum 1 (exceed)			-.044	.109	-.017		
Curriculum 2 (met)			-.009	.193	-.002		
College Prep Algebra			-.064	.175	-.014		
Pre-Calculus			.025	.094	.012		
Calculus			-.096	.103	-.039		

Note. Wherry Adjusted R^2 for Model 3: .177. Stein Adjusted R^2 for Model 3: .152.

**p<.01, *p<.05.

R^2 be used to assess the effects of predictors on a dependent variable. To restate, the final model, containing all covariates and predictors, could be expected to account for 15.2 % of the variance in first semester college GPA for a different sample of participants from this same population.

Four variables were significant predictors in the final regression model. It should be noted that predictive relationships were based on standardized partial regression coefficients. This meant that all other variables in the equation were controlled for each separate coefficient. High school GPA was the strongest contributor ($\beta = .338, p < .01$). As expected, the relationship between high school GPA and first semester college GPA was positive. The second strongest contributor ($\beta = -.111, p < .01$) was the variable representing low socioeconomic status (SES 1). The negative direction of the relationship indicates an association of high first semester college GPA with not having low SES.

Two other variables were significant ($p < .05$) predictors. Sex ($\beta = -.092, p < .05$) was negatively associated with first semester college GPA. Based on the coding for sex (female = 0, male = 1), this relationship indicates high first semester college GPA was significantly related to being female. The CATS writing portfolio score ($\beta = .088, p < .05$) was positively associated with high first semester college GPA and was the only predictor outside of the covariates with a significant contribution to the regression equation.

In summary, correlations between the predictors and the criterion variable, and intercorrelations, were uniformly significant. The exception was college prep algebra's statistically insignificant relationships to most of the other predictors. In regards to the

final regression model, research hypothesis 1 was not supported. The null hypothesis was not rejected. CATS scores and college preparatory variables did not significantly contribute to the prediction of first semester college GPA beyond the contribution of the control variables.

Regression on First Year College GPA (Hypothesis 2)

Table 4 shows Pearson product-moment correlation coefficients, r, for first year college GPA and selected covariates and predictors. Table 4 does not include categorical covariates and predictors with more than two levels, represented in the regression by dummy-coded variables (Pedhazur, 1997). Ninety percent of the correlations between the dependent variable and the predictors and the intercorrelations between predictors are statistically significant. Substantial correlation among predictors indicates multicollinearity, which complicates the interpretation of regression (Cohen & Cohen, 1975).

Covariate and predictor correlations to the dependent variable increased from first semester to first year GPA. The two variables with lower correlations to first year GPA than first semester GPA were sex ($r = -.169$ to $-.141$) and college preparatory algebra in high school ($r = -.069$ to $-.064$). High GPA was slightly less associated with being female for first year GPA than for first semester GPA. The predictor with the highest correlation to first year college GPA was high school GPA ($r = .488$). The next highest correlations to the criterion were ACT score ($r = .259$), CATS writing portfolio ($r = .264$), CATS reading ($r = .254$), CATS social sciences ($r = .244$), and CATS math ($r = .226$). The weakest correlation to first year college GPA was completion of college preparatory algebra in high school ($r = -.064$). The completion of college preparatory

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Table 4

Intercorrelations for Selected Variables for First Year GPA Regression

Variable	1	2	3	4	5	6	7
1. Spring 2002 GPA	- -						
2. Sex	-.141**	- -					
3. High School GPA	.488**	-.162**	- -				
4. ACT Score	.259**	.179**	.258**	- -			
5. CATS Math Score	.226**	.218**	.141**	.579**	- -		
6. CATS Reading Score	.254**	-.126**	.219**	.450**	.448**	- -	
7. CATS Science Score	.188**	.217**	.129**	.527**	.671**	.469**	- -
8. CATS Social Science Score	.244**	.116**	.192**	.474**	.611**	.502**	.699**
9. CATS Writing Portfolio Score	.264**	-.142**	.284**	.412**	.251**	.316**	.260**
10. CATS Writing-on-Demand Score	.208**	-.112**	.208**	.240**	.165**	.231**	.156**
11. High School College Prep Algebra	-.064	.004	-.113**	-.093*	-.026	-.052	-.028
12. High School Pre-Calculus	.125**	.115**	.215**	.324**	.318**	.189**	.239**
13. High School Calculus	.119**	.160**	.235**	.388**	.284**	.131**	.191**

$**p<.01$, $*p<.05$.

Table 4 (continued)

Intercorrelations for Selected Variables for First Year GPA Regression

Variable	8	9	10	11	12	13
1. Spring 2002 GPA						
2. Sex						
3. High School GPA						
4. ACT Score						
5. CATS Math Score						
6. CATS Reading Score						
7. CATS Science Score						
8. CATS Social Science Score	- -					
9. CATS Writing Portfolio Score	.290**	- -				
10. CATS Writing-on-Demand Score	.216**	.203**	- -			
11. High School College Prep Algebra	-.010	-.022	-.065	- -		
12. High School Pre-Calculus	.225**	.124**	.095**	-.279**	- -	
13. High School Calculus	.113**	.167**	.120**	-.126**	.402**	- -

$**p<.01, *p<.05.$

algebra in high school produced the fewest significant intercorrelations. The exceptions were negative relationships with high school GPA ($r = -.113$), ACT score ($r = -.093$), completion of pre-calculus ($r = -.279$), and completion of calculus ($r = -.126$).

Table 5, with the same headings as Table 3 (B, SEB, β, R^2, and ΔR^2), contains the results of the hierarchical multiple regression with first year GPA as the criterion. All covariates entered the regression at Step 1. The R^2 at this step was significant ($p < .01$) at .292. The addition of CATS scores at step 2 ($\Delta R^2 = .017$) made a statistically significant ($p < .05$) contribution to R^2. College preparation predictors, added at step 3 ($\Delta R^2 = .005$), made a statistically insignificant contribution to R^2. The unadjusted R^2 for the final model was .314, significant at the .01 level. Wherry adjusted R^2 was .291. The Stein adjusted R^2, a measure of the regression equation's predictive validity on a different sample from the same population, was .267. The final model, containing all covariates and predictors, could be expected to account for 26.7% of the variance in first semester college GPA for a different sample of participants from the same population.

The three significant covariate predictors from the first semester college GPA final regression model were the significant covariate predictors for this regression's final model: (a) high school GPA, (b) SES 1, and (c) sex. High school GPA was the strongest contributor ($\beta = .424$, $p < .01$). A relatively high value for high school GPA was associated with high first year college GPA. SES 1 was the second strongest contributor ($\beta = -.141$, $p < .01$). As with the previous regression, relatively high first year college GPA was associated with not having low socioeconomic status. The relative contribution of both variables, high school GPA and SES 1, toward predicting academic performance was greater for first year college GPA than for first semester college GPA.

Table 5

Summary of Hierarchical Regression Analysis with First Year GPA Criterion

Variable	B Step 1	B Step 2	B Step 3	SEB Step 3	β Step 3	R^2	ΔR^2
Step 1: Covariates						.292**	.292**
Sex	-.165	-.149	-.143	.069	-.082*		
Race 1 (White)	.232	.104	.106	.235	.052		
Race 2 (Black)	.196	.059	.069	.238	.031		
Race 3 (Asian)	.293	.216	.247	.284	.050		
SES 1 (low)	-.489	-.438	-.456	.127	-.141**		
SES 2 (medium)	-.157	-.118	-.105	.173	-.023		
High School GPA	.820	.773	.787	.072	.424**		
ACT Score	.027	.003	.004	.011	.020		
Step 2: CATS Scores						.309**	.017*
Math		.062	.071	.034	.110*		
Reading		.040	.042	.040	.047		
Science		-.005	-.002	.051	-.002		
Social Science		.024	.026	.040	.035		
Writing Portfolio		.063	.061	.055	.045		
Writing-on-Demand		.083	.084	.064	.048		
Step 3: College Prep						.314**	.005
Curriculum 1 (exceed)			-.122	.090	-.055		
Curriculum 2 (met)			-.143	.160	-.037		
College Prep Algebra			-.086	.150	-.021		
Pre-Calculus			-.082	.077	-.044		
Calculus			-.054	.084	-.027		

Note. Wherry Adjusted R^2 for Model 3: .291. Stein Adjusted R^2 for Model 3: .267.

**$p<.01$, *$p<.05$.

Two other variables were significant ($p < .05$) predictors. Sex ($\beta = -.082, p < .05$) was negatively associated with first semester college GPA. Males were significantly more likely to earn a low first year college GPA. The CATS math score ($\beta = .110, p < .05$), the only variable of interest to make a significant contribution to the regression equation, was positively associated with first year college GPA.

In summary, correlations between the predictors and the criterion variable, and intercorrelations, were uniformly significant. The exception was college prep algebra's statistically insignificant relationships to most of the other predictors. In regards to the final regression model, research hypothesis 2 was supported. The null hypothesis was rejected. CATS scores significantly ($p < .05$) contributed to the prediction of first year college GPA beyond the contribution of the control variables. The addition of CATS scores resulted in a statistically significant increase ($\Delta R^2 = .017$) in the regression equation's ability to account for variance in the prediction of first year college GPA.

Discriminant Analysis on Persistence to Sophomore Year (Hypothesis 3)

The research design required three separate discriminant analysis calculations to attain the necessary measures of statistical significance, Wilks' lambdas, between the entry of covariates (Step 1), CATS scores (Step 2), and college preparatory variables (Step 3). Box's test of equality of covariance matrices was statistically significant. The population covariance matrices for persisters and non-persisters were significantly different. Box's test is very sensitive to nonnormality. Tabachnick and Fidell (2001) recommend variable transformation if inference is the goal and sample size is small. As this sample more closely approximates the population, capturing all qualified participants, inference is less

the goal than comparing sets of variables in how they discriminate between persisters and non-persisters.

Since the categorical variable persistence had two levels (persister, non-persister), the discriminant analysis produced one discriminant function. Table 6 shows the standardized discriminant coefficients and univariate Fs for each variable and canonical correlation squared and increase in canonical correlation squared (R^2 and ΔR^2) for each step of the analysis. Standardized discriminant coefficients are analogous to standardized regression coefficients (β), providing an indication of the relative contribution of each variable to the discriminant function. The univariate F indicates the relationship between the variable and the criterion.

Table 7 shows both correlations with the discriminant function and standardized discriminant function coefficients. Tabachnick and Fidell (2001) suggested any correlation of .33 or greater be considered important for interpretation. This criterion ($r \geq .33$) indicates a variable accountable for at least 10% of the variance in the dependent variable.

One covariate was an important contributor to the discriminant function. High school GPA ($r = .727$) was the overall strongest predictor of persistence status. Persistence was associated with higher GPAs in high school. SES 1 and sex, significant contributors to both college GPA regression equations, were not important contributors to the discriminant function for persistence.

Four of six CATS score were related to persistence: (a) math ($r = .403$), science ($r = .406$), social sciences ($r = .416$), and writing portfolio ($r = .398$). The correlation for CATS writing-on-demand score was slightly below the cutoff value of .33. The CATS

Table 6

Summary of Hierarchical Discriminant Analysis with Persistence as Criterion

Variable	Standardized Discriminant Coefficient			Univariate F	Canonical R^2	
	Step 1	Step 2	Step 3		R^2	ΔR^2
Step 1: Covariates					.089**	.089**
Race 1 (White)	-.330	-.497	-.452	1.241		
Race 2 (Black)	.093	-.083	-.061	.089		
Race 3 (Asian)	.117	.050	.035	3.421		
SES 1 (low)	-.400	-.338	-.341	4.944*		
SES 2 (medium)	-.187	-.150	-.148	.394		
Sex	.219	.223	.195	.376		
High School GPA	.880	.712	.664	46.283**		
ACT Score	.148	-.202	-.267	7.506**		
Step 2: CATS Scores					.111**	.022
Math		.176	.133	14.299**		
Reading		-.072	-.073	3.751		
Science		.251	.257	14.444**		
Social Science		.069	.098	15.209**		
Writing Portfolio		.251	.248	13.877**		
Writing-on-Demand		.197	.178	9.452**		
Step 3: College Prep					.114**	.003
Curriculum 1 (exceed)			-.028	.044		
Curriculum 2 (met)			.061	.283		
College Prep Algebra			-.074	3.393		
Pre-Calculus			.090	13.125**		
Calculus			.131	11.556**		

Note: Canonical correlation squared is designated R^2 in this table.

**$p<.01$, *$p<.05$.

Table 7

Discriminant Analysis with all Predictors: Correlations with Discriminant Function and

Standardized Discriminant Function Coefficients

Variable	Correlation with Discriminant function	Standardized Discriminant Function Coefficient
Step 1: Covariates		
Race 1 (White)	-.119	-.452
Race 2 (Black)	.032	-.061
Race 3 (Asian)	.198	.035
SES 1 (low)	-.237	-.341
SES 2 (medium)	-.067	-.148
Sex	.065	.195
High School GPA	.727*	.664
ACT Score	.293	-.267
Step 2: CATS Scores		
Math	.403*	.133
Reading	.207	-.073
Science	.406*	.257
Social Science	.416*	.098
Writing Portfolio	.398*	.248
Writing-on-Demand	.328	.178
Step 3: College Prep		
Curriculum 1 (exceed)	.022	-.028
Curriculum 2 (met)	-.057	.061
College Prep Algebra	-.197	-.074
Pre-Calculus	.387*	.090
Calculus	.363*	.131

*Values $\geq$ .33 were considered important contributors to the discriminant function.

reading score, though not important to the discriminant function, was negatively associated with persistence. Two college preparatory variables, the completion of pre-calculus ($r = .387$) and calculus ($r = .363$) in high school, were positively associated with persistence.

Each step of the discriminant analysis produced a significant canonical R^2. The F statistic, calculated using the Wilk's Λ generated at each step of the hierarchical discriminant analysis, provided a measure of significant improvement in classification for each set of variables (CATS scores and college preparation variables) added after the covariates (Tabachnick & Fidell, 2001). The additions of CATS scores at Step 2 and college preparation variables at Step 3 provided insignificant improvements to the prediction of persistence.

The canonical R^2 from step 1, covariates, was .089 ($\Lambda = .911$, χ^2 (8) = 64.21, $p < .01$). The control variables accounted for 8.9% of the variance in persistence. After adding CATS scores ($\Delta R^2 = .022$, n.s.), the proportion of variance accounted for in the criterion variable rose to .111 ($\Lambda = .889$, χ^2 (14) = 78.64, $p < .01$). Step 3, adding the college preparatory variables ($\Delta R^2 = .003$, n.s.), made a small, statistically insignificant, improvement. The final discriminant function accounted for 11.4% of the variance in persistence ($\Lambda = .885$, χ^2 (19) = 81.30, $p < .01$). Neither CATS scores (F (14, 665) = 1.17, n.s.) nor college preparatory variables (F (19, 660) = .157, n.s.) added significant predictive power to the discriminant function.

Table 8 displays the classification results for each step of the discriminant analysis. Covariates correctly classified 64.2% of the sample. Correct and incorrect classifications were split equally, based on percents, between persisters and non-persisters. Covariates

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Table 8

Classification Table for Hierarchical Discriminant Analysis

	Classified Group	
	Persisters	Non-persisters
Actual Group/Variable		
Step 1: Covariates	(N = 535)	(N = 158)
Persisters	344 (64.3%)	191 (35.7%)
Non-persisters	57 (36.1%)	101 (63.9%)
Overall Correct	64.2%	
Step 2: CATS Scores added	(N = 525)	(N = 155)
Persisters	354 (67.4%)	171 (32.6%)
Non-persisters	49 (31.6%)	106 (68.4%)
Overall Correct	67.6%	
Step 3: College Prep added	(N = 525)	(N = 155)
Persisters	353 (67.2%)	172 (32.8%)
Non-persisters	48 (31.0%)	107 (69.0%)
Overall Correct	67.6%	

and CATS scores (step 2) correctly classified 67.6% of the sample. The final discriminant function (covariates, CATS scores, and college preparatory variables) provided no improvement over step 2. The final discriminant function correctly predicted the group membership of 67.6% of the sample as persisters or non-persisters.

In summary, the strongest predictor of persistence was high school GPA. Four of six CATS scores, plus the completion of pre-calculus and calculus in high school, were important contributors to the prediction of persistence. However, neither CATS scores nor college preparatory scores significantly contributed to the classification power of the final discriminant function beyond the contribution of the control variables. Hypothesis 3 was not supported. The null hypothesis was not rejected.

CHAPTER V

DISCUSSION

This chapter's first section briefly restates the context of this study, its purpose, and the methodology. The next section focuses on a discussion of the results and their relationship to previous research. The final section includes implications for educators and researchers.

Study Context, Purpose, and Methodology

Kentucky legislators and educators placed themselves on the forefront of educational reform with the passage of the Kentucky Education Reform Act (KERA) in 1990 and the Kentucky Postsecondary Education Improvement Act (KPEIA) in 1997. These pieces of legislation are comprehensive, ambitious attempts to improve Kentucky's public education systems. More responsive, accountable, and effective public education is not, however, the final goal. Public education is a means to an end: an informed and well-trained citizenry capable of making positive contributions to the community and state.

KERA and KPEIA acknowledge the importance of the student transition from high school to college with goals and indicators focused on facilitating this step into postsecondary education. Are there untapped resources available to educators to help students complete the move from high school to college? Are there alternatives to ACT and SAT test scores currently used by most colleges to make admission decisions? Many researchers question the utility (Larson & Scontrino, 1976), validity (Dalton, 1976;

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Wainer, Saka, & Donoghue, 1993), and cost-effectiveness (Crouse & Trusheim, 1991) of these national college admissions tests.

The current study drew upon a theoretical framework supported by Burnham and Hewitt (1972) and Ansley and Forsyth (1983). Burnham and Hewitt sought additional sources of variance in college performance in the high school record. Ansley and Forsyth concentrated their study on the predictability of college performance using scores generated from a testing system specific to one state's public secondary educational system. The current study investigated the predictive potential of Commonwealth Accountability Testing System (CATS) scores and college preparation variables in relation to control variables established by the literature (ACT score, high school GPA, sex, race, and socioeconomic status). The three criterion variables were first semester college GPA, first year college GPA, and persistence to the sophomore year. CATS scores and the college preparation variables are available in the high school record.

The research design regressed the control variables, CATS scores, and college preparation variables on first semester and first year college GPA in a hierarchical fashion with three steps. The three groups of variables also were entered setwise in a discriminant analysis to predict persistence status at the beginning of the sophomore year. Three research hypotheses concentrated on the predictors' ability to add significantly to the prediction of the criterion variables beyond the contribution of the control variables.

Discussion of the Results

Hypothesis 1

The result of the regression on first semester college GPA (see Table 3) did not reject the null hypothesis for the first research question. CATS scores and college preparation

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variables did not add significantly to the predictive power of the model containing the control variables. The dominance of high school GPA in the prediction equation for first semester college GPA agrees with the finding by previous researchers (Maryland State Higher Education Commission, 1975; Chase & Jacobs, 1989). As is frequently the case, past performance is the best predictor of future performance. Academic performance in high school, therefore, is the best predictor of academic performance in college. ACT score, advertised as an indicator of college potential, pales in comparison to past performance (high school GPA) as a predictor of first semester college GPA.

Low socioeconomic (SES 1) status was the second strongest contributor to the prediction of first semester college GPA. Caution is necessary when interpreting this finding. SES 1 is a fragment of the original variable, socioeconomic status. A high value on SES 1 indicates low socioeconomic status. A low value indicates not being of low socioeconomic status. College students from low socioeconomic backgrounds require special attention to achieve commensurate level of academic performance as students with higher socioeconomic status. Students from less-privileged backgrounds tend to live off campus more frequently than students from high socioeconomic backgrounds, are not as well-prepared for college, are frequently from a minority, and work throughout their college careers (Valverde, 1985). Numerous interrelated factors combine to make the collegiate environment challenging for low SES students.

The third significant covariate contributor to the regression model was sex. Differential predictability by sex has been reported by numerous researchers (Bean & Covert, 1973; Bean, 1980). Seashore (1962) reported that the academic performances of women are more predictable than for men. The difference in predictability increases

from high school to college. Many researchers reported higher overall grades for females in high school and college (Klugh & Bierly, 1959). The present study's findings agree, significantly associating high first semester college GPA with being female. Of the remaining control variables, ACT score made the smallest contribution to the equation.

The only variable of interest to significantly contribute to the prediction of first semester college GPA was the CATS writing portfolio score. The current study has no insight or explanation for why one CATS score was more significant than another. One difference between the writing portfolio score and all other CATS scores is the longitudinal aspect of the portfolio score. CATS tests are conducted at specific times during the school year. The one exception is the writing portfolio. The portfolio score is an indication of performance over time, not on a given test day. This method of longitudinal measurement is comparable to the high school GPA's longitudinal accumulation of performance data.

CATS scores and college preparation variables did not significantly improve the prediction model beyond the contribution of the covariates. The resources spent gathering, organizing, and analyzing six CATS scores and five college preparation variables produced an additional, and statistically insignificant, 1.5% of variance accounted for in the criterion variable. High first semester college GPA was significantly associated with a high GPA in high school, being female, not being from a low SES background, and with high scores on the CATS writing portfolio. The adjusted practical significance of the final model, .152, is the proportion of variance it should account for in first semester college GPA for a different sample from the same population. This finding indicates a medium effect size (Cohen, 1988).

Hypothesis 2

The results of the regression on first year college GPA (see Table 5) supported acceptance of the second research hypothesis. CATS scores added significant predictive power to the model containing the control variables. The three strongest predictors for first semester college GPA were the strongest predictors for first year college GPA. The relative contributions of high school GPA and SES 1 to the final prediction model grew approximately 25% from first semester to first year college GPA. The contribution of sex, though still significant, dropped slightly. With only covariates in the model, the prediction equation accounted for 18.5% of the variance in first year college GPA.

The addition of CATS scores at step 2 significantly improved the prediction model. The one significant predictor was CATS math score. No college preparation variables were significant contributors at step 3. The final model accounted for 30.9% of the variance in first year college GPA. This prediction equation could be expected to account for 26.7% of the variance in first year college GPA, a high effect size (Cohen, 1988), for a different sample from the same population. Using the same predictors, first year college GPA was 50% more predictable than first semester college GPA.

These results compare to the findings reported by Hills (1964). Hills' University of Georgia study reported similar multiple correlations between high school GPA, admission test score, and freshman GPA. As with both regressions in the current study, Fincher (1974) found high school GPA the strongest predictor for first semester and first year GPA. Consistent with some researchers' concern for the decreasing correlation of aptitude and ability test scores to college performance (Wainer, Saka, & Donoghue, 1993), ACT scores for this sample failed to contribute significantly to either regression.

Hypothesis 3

The result of the discriminant analysis (see Table 6) on persistence to the sophomore year supported retention of the null hypothesis. The addition of CATS scores and college preparation variables provided no significant discriminative power beyond that from the control variables. The strongest predictor for both GPA regressions (high school GPA) was also the strongest predictor of persistence (see Table 7). Consistent with its contribution to both GPA regressions, ACT score was not a significant discriminator of persistence status. Sex, a significant predictor for first semester and first year GPA, dropped from statistical significance.

Four of six CATS scores were important contributors to the discriminant function predicting persistence. Three of those CATS tests were taken during the junior year of high school. Two college preparation variables, completion of pre-calculus and calculus in high school, were associated with persistence to the sophomore year.

Contrary to Tinto's (1975) and Bean's (1980) theoretical models of college student persistence, which incorporated measures of students' social and academic integration into the college, the current study used only pre-enrollment variables. The final discriminant function was a statistically significant discriminator of persistence, accounting for 11.4% of the variance in persistence. When Cabrera, Castañeda, Nora, and Hengstler (1992) tested the persistence models of Tinto (1975) and Bean (1980), their models accounted for 38% and 44%, respectively, of the variance in persistence to the sophomore year. Both models require a longitudinal research design, multiple questionnaires, and post-enrollment data. Pascarella and Terenzini (1980) reported similar results in their assessment of Tinto's model.

The present study's finding approximate the results reported by Pascarella, Duby, Miller, and Rasher (1981). Their persistence study included students from an urban, nonresidential university and used demographic, pre-enrollment variables as predictors. Pascarella et al. added first quarter college GPA and credits earned to the discriminant equation and accounted for 20% of the variance in persistence.

The present study's discriminant function (see Table 8) correctly classified 67.6% of the participants. Prior probabilities for both groups were set at 50%. The 67.6% accuracy rate is conservative to maximize accurate predictions for the smaller non-persister group. When actual group sizes set the prior probabilities, the classification rate improved to 77.4%. The price for better overall classification is less accurate prediction for the smaller non-persister group. Eighty-nine percent of non-persisters were misclassified as persisters. Identifying non-persisters is commonly the goal of persistence research. Early identification provides time for university personnel to intervene, assist, and improve retention rates.

Implications for Education and Research

The current study presents a number of implications for secondary and postsecondary educators. The focal point is the transition between high school and college, the overlap between the goals of the Kentucky Education Reform Act (1990) and the Kentucky Postsecondary Education Improvement Act (1997). This transition period, the freshman year, is a critical time in a college student's educational career (Tinto, 1993). Student success, both in the context of academic GPA and persistence to graduation, are desirable outcomes for the student, the institution, and the state. What can be done, based on the results of the current investigation, to facilitate student success? Two possibilities exist.

Using only the pre-enrollment variables considered in this study, which are available before a student takes the first college class, an educator could predict with significant precision that student's first semester and first year college GPA. Some form of this prediction occurs at many universities with assignments to developmental courses or programs for 'at-risk' students. Another powerful tool is the prediction of persistence. Before students even arrive on campus for fall classes, college officials can identify two-thirds of the students at-risk for not returning for the sophomore year. Additional accuracy in the prediction of persistence is possible with the inclusion of first semester college GPA (Lewallen, 1993).

The population of students predicted for low grades and low persistence is worthy of attention. Academic performance and personal decisions made during the first year of college, a tumultuous year of change and adjustments for students, are not necessarily indicative of future college performance. On a monetary level, it is cheaper to retain a current student than to recruit a new student (Bean, 1990). Effort and resources in this endeavor are wholly justified in the pursuit of Kentucky's educational goals. A proactive intervention of this nature requires integration and collaboration between Kentucky's secondary and postsecondary education establishments.

A consideration for college admissions officials is the insignificant contribution of ACT scores to the prediction of college academic performances and persistence relative to the other control variables. When high school GPA, sex, and SES are known, ACT accounts for an insignificant amount of variance in first semester and first year college GPA. An ACT score requirement is standard practice among colleges and universities. In light of the controversy concerning the validity and reliability of this test, particularly

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in regards to race, is an ACT score requirement for university admission a necessary components of an effective enrollment management plan. The results of the current study cast doubt on their usefulness as predictors of college GPA and persistence.

Information Integration

Kentucky's public education system can be viewed from different perspectives. Each perspective provides insight on the implications of information flow between institutions. If the secondary and postsecondary education systems are viewed as separate organizations, each with their own goals, priorities, and customers, the flow of information between institutions is limited, unstandardized, and contributes little to the overall effectiveness of either enterprise. There is another option.

Kentucky's secondary and postsecondary education systems can be seen as one provider of public education. The recent educational reforms (KERA and KPEIA) blurred the division of responsibilities between secondary and postsecondary education. Educators must be concerned with, and connected to, their students' success outside the rigid boundaries of their own domains. Both pieces of legislation focus their respective constituent attention on student preparation for college. Neither secondary nor postsecondary institutions can reach their goals without the cooperation of the other. A JCPS graduate's success at U of L is the result of a combined effort of both institutions.

The key to successful collaboration between the secondary and postsecondary education systems is information supply chain management. This study tapped a small portion of the information available to college educators from the high school record. Socioeconomic status, derived from JCPS's free and reduced lunch status, was a statistically significant ($p < .01$) predictor of first semester college GPA, first year college

GPA, and persistence ($p < .05$). The potential for more powerful information applications exists with the introduction of information supply chain management principles between the University of Louisville and the Jefferson County Public School system.

Private industry's response to the profit pressures experienced in the 1980s and 1990s included the following information supply chain management principles: (a) to learn about suppliers, (b) to collaborate within the information supply chain on product development, (c) to learn how the information supply chain impacts each organizational component, (d) to capitalize on new technologies, (e) to understand requirements for data distillation, (f) to adopt concepts of personalization and mass customization, and (g) to maintain open communication channels with suppliers, partner, and customers (Powell, 2001). Each of these principles, perfected by private industry to remain competitive and profitable, holds value for Kentucky public education within the context of an information supply chain.

Kentucky's public universities should learn about their suppliers. More than simply understanding secondary education, universities should be familiar with the product they receive from different regions, counties, and specific high schools. Collaboration between the secondary and postsecondary education systems capitalizes on the resources available to each institution. A comprehensive management information system within each organization maximizes the usefulness of the data acquired through the information supply chain. An information supply chain model is necessary for Kentucky public education to achieve the positive results expected by the people of the Commonwealth.

Implications for Research

The implications for future research indicated by the present study range from considerations of definitions to variable selection. One of the methodological problems of college persistence research cited by Pantages and Creedon (1978) and Tinto (1975) was inconsistent definitions. The present study defined persistence with a dichotomous variable (no = 0, yes = 1) describing a participant's enrollment status at the beginning of the fall 2002 semester. Additional discriminatory power, or usefulness to practitioners, is possible by further differentiating the persistence criterion (e.g., dropout, stopout, or persister) or level of enrollment (e.g., full-time, half-time, part-time).

This study's definition of socioeconomic status was based upon data from the high school record. Even with the restricted variability of this predictor (three levels) and the archival nature of its origin, SES 1 was a significant predictor. A measurement of socioeconomic status during college, more current than the high school record, could account for a higher proportion of variance in college GPA and persistence.

The final definition issue involves the sample participants. A U of L student's record reflects a 0.00 GPA for the freshman fall semester if the student withdraws from all classes during that semester. The present study assumed these students earned no GPA, versus a 0.00 GPA for students with all failing grades. Including withdrawn students' 0.00 freshman fall GPA with the 0.00 GPA earned by students with failing grades would produce a different regression equation. The issue revolves around the focus of the research question. Withdrawn students, like those failing all their courses, certainly fail to progress toward graduation, however a variety of critical issues could separate the two groups. Future research could explore these differences and their impact on student

progress toward educational goals. In addition to considerations of definitions affecting future research, different variables hold promise for following investigations.

The CATS scores available for the present study included four or eight levels. The original CATS scores were categorical variables with numerical counterparts (e.g., 13 = Novice, 60 = Apprentice, 100 = Proficient, and 140 = Distinguished). Each CATS score was converted to a four- or eight-level continuous variable for inclusion in the regression and discriminant analyses. CATS scores are now calculated and recorded with far greater ranges and variability. Greater variability in a predictor potentially translates into greater predictive power on the criterion. Even with CATS scores' limited ranges, the multiple correlations of CATS scores to first semester ($r = .265$) and first year ($r = .362$) college GPA exceeded those of the ACT score ($r = .123$ and .259, respectively). In fact, the CATS writing portfolio score was more highly correlated to both academic performance measures than was ACT score. CATS scores hold significant promise for future research.

Another source of predictive power available in the present study, but untapped as a predictor, is first semester college GPA. Previous research findings indicate the first grades earned in college are powerful predictors of future college academic performance and persistence (Pascarella, Duby, Miller, & Rasher, 1981). With first semester college GPA added to the present study's discriminant analysis, the classification rate improved from 67.6% to 79.1%. The proportion of variance accounted for in first year college GPA improved from 31.4% to 73.7% with the addition of first semester college GPA as a predictor. Future research could further assess the impact of this variable on the

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prediction of first year GPA and persistence to the sophomore year at the University of Louisville and other Kentucky universities.

Conclusion

The development of predictors for college student academic performance and persistence is important because the success of the institution is directly linked to student outcomes. This study established that variables available in the high school record were significantly related to college GPA and persistence. The tasks that remain are to further explore the relationship between JCPS and U of L to refine the prediction equation and to expand the scope of this investigation to include other Kentucky school districts and universities. It is hoped other researchers will continue this line of research because educational leaders have a responsibility to (a) determine what influences academic performance and persistence, and (b) develop policies and procedures to improve student outcomes.

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